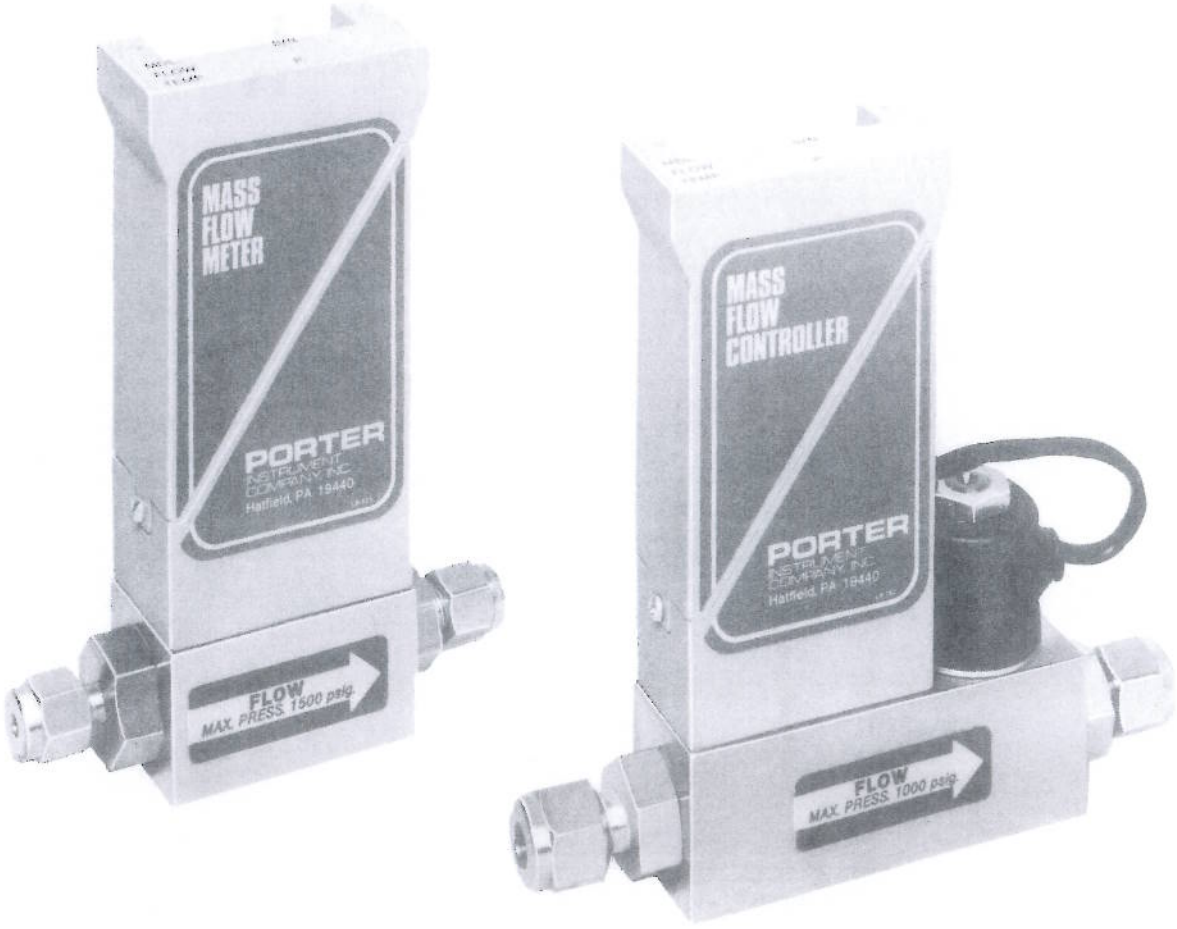
Appendix A

FAST RESPONSE MASS FLOWMETER AND CONTROLLER SERIES 100F AND 200F

TECHNICAL AND USERS MANUAL



PORTER INSTRUMENT COMPANY, INC.

245 TOWNSHIP LINE RD. P.O. BOX 907 HATFIELD, PA 19440-0907 USA [215] 723-4000 / FAX [215] 723-2199

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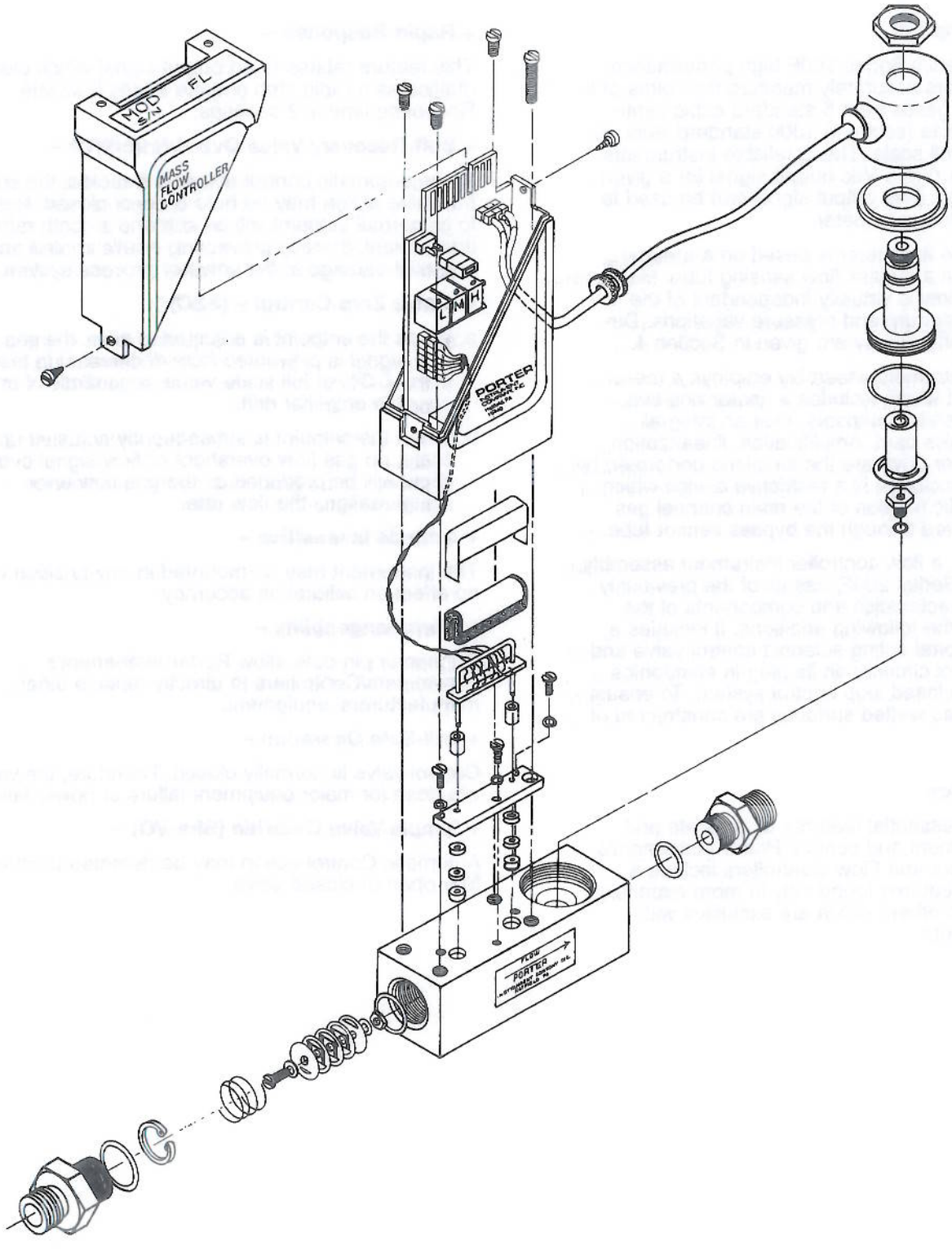
Exploded View of Porter Instrument's Series 200 Thermal Mass Flow Controller



SECTION 1

INTRODUCTION

System Description

Porter Instrument's Series 100F high performance Mass Flowmeters accurately measure flow rates of a wide variety of gases from 5 standard cubic centimeters per minute (sccm) to 1000 standard liters per minute (slpm) full scale. These reliable instruments provide a linear 0 to 5 Vdc output signal for a given flow rate change. This output signal can be used to drive a digital flow rate meter.

Operation of the flowmeter is based on a thermal measurement in a bypass flow sensing tube. Measurement of mass flow is virtually independent of the effects of temperature and pressure variations. Details of operational theory are given in Section 4.

A flowmeter instrument assembly employs a mass flow sensor unit which includes a heater and two precision temperature sensors, plus an integral plug-in electronics card. Amplification, linearization and output meter drive are the functions performed by this card. Also included is a restrictive device which causes a specific fraction of the main channel gas flow to be directed through the bypass sensor tube.

By comparison, a flow controller instrument assembly, designated as Series 200F, has all of the previously mentioned characteristics and components of the flowmeter with the following additions. It includes a built-in proportional acting solenoid control valve and additional control circuitry on its plug-in electronics card forming a closed loop control system. To ensure gas purity, all gas wetted surfaces are constructed of stainless steel.

System Features

Aside from the essential features of accurate and linear measurement and control, Porter Instrument's Mass Flowmeters and Flow Controllers include a host of deluxe features found only in more expensive instruments and others which are exclusive with Porter Instruments.

+ Rapid Response –

This feature relates to an output signal which closely duplicates a rapid step change in gas flow rate. Response time is 2 seconds.

+ Soft Recovery Valve Override (SRVO) –

When automatic control action is disabled, the control valve action may be held open or closed. Return to its normal setpoint will be soft and smooth rather than violent, thereby preventing erratic control and potential damage to the valve or process system.

+ Stable Zero Control – (SZC)

a. When the setpoint is adjusted to zero, the gas flow signal is prevented from decreasing to less than +0.3% of full scale value, regardless of any possible amplifier drift.

b. When the setpoint is subsequently adjusted up scale, no gas flow overshoot or flow signal overshoot will be produced as the gas flow error signal realigns the flow rate.

+ Attitude Insensitive –

The instrument may be mounted in any position with no effect on calibration accuracy.

+ Interchangeability –

Connector pin-outs allow Porter Instrument's Flowmeters/Controllers to directly replace other manufacturers' equipment.

+ Fail-Safe Operation –

Control valve is normally closed. Therefore, the valve will close for major equipment failure or power failure.

+ Simple Valve Override (Sim-VO) –

Automatic Control action may be defeated to obtain fully open or closed valve.

SECTION 2

SPECIFICATIONS

SPECIFICATIONS COMMON TO ALL 100F/200F SERIES MODELS

Operating Temperature Range —
–10 to 70°C (+14 to 158°F).

Accuracy and Linearity —
± 1% Full Scale
(all models except Models 114 & 204A)
± 1.5% Full Scale (Models 114 & 204A)

Temperature Coefficient —
± 0.1%/°C of Full Scale

Pressure Coefficient —
0.1%/atmosphere

Repeatability —
Within 0.2% Full Scale at any constant temperature within operating temperature range

Response Time —
2 seconds

Output Flow Signal —
0 to 5 Vdc linear, for 0 to 100% full scale, driving into 1500 ohms or greater

Rangeability — 50:1

Set-Point Control —
0 to 100% full scale gas flow for 0 to 5 Vdc input

Power Requirements —
+15 Vdc and –15 Vdc, both at 25 mA dc for 100F Series Models
+15 Vdc at 25 mA dc and –15 Vdc at 300 mA max for 200F series Models

Gas Connections

Models	Fitting Type																			
	Compression											Vacuum Coupling								
	Swagelok®							CPI®		A-Lok®		VCO®			VCR®			UltraSeal®		
	1/8"	1/4"	3/8"	1/2"	3/4"	6mm	10mm	3/8"	1/2"	3/8"	1/2"	1/4"	3/8"	1/2"	1/4"	3/8"	1/2"	1/4"	3/8"	1/2"
001 111 201	X	X	X	X		X	X	X		X		X	X	X	X	X	X	X	X	
002 112 202 202A 251		X	X	X		X	X	X		X		X	X	X	X	X	X	X	X	
003A 113 203A			X	X	X				X		X		X	X		X	X			X
114 204A				X	X				X		X		X	X		X	X			X

*Trademarks
Swagelok = Swagelok Company
VCR, VCO = Cajon Company
CPI, A-Lok = Parker Hannifin Corp.
UltraSeal = Parker Hannifin Corp.

SECTION 3

INSTALLATION AND OPERATING PROCEDURES

General Information

The equipment should be installed in a clean, dry area with adequate space surrounding it for ease of maintenance, if required. Ambient temperature should not exceed the specified operating range (14 to 158°F). Also recall from the specifications sections that the basic one percent of full scale flow rate accuracy figure must be modified 0.1 percent per 1.8°F (1°C) for an operating temperature other than the calibration temperature, 70°F or 21.1°C. Instruments are not attitude sensitive and may be mounted in any position.

Gas Connections

Each instrument has two threaded gas fitting connecting ports, one at the gas inlet, the other at the gas outlet, at the ends of the base block. These gas line connections accept fittings of the type listed in the specifications section. For compression type fittings, make certain the tubing which mates to the fitting is correctly sized, clean and is seated against the shoulder in the body of the compression fitting, prior to tightening the connection. Tighten the rotatable hex nut fitting sufficiently to prevent leakage. Refer to the applicable fitting manufacturer's data for specific recommendations regarding installation and tightening. Test joints for leaks. The inlet connection contains a 50 micron mesh filter screen which prevents foreign matter from entering the instrument. Only clean dry gas is to be used in the system.

External Electrical Connections

Important Notice

Do not confuse the two "common" references noted herein. Circuit common acts as a common return for all functional circuit blocks. Valve common is the return wire for the solenoid control valve.

Figure 3-1 shows the diagram for external electrical connections to be made to the 100F series Flowmeter. Table 3-1 details the individual functions for the flowmeter's connector, which is designated as socket J2. For reference, J1 is the temperature sensor/heater power output socket located inside the instrument's housing. It accepts plug P1, which feeds the sensor/heater components. If the instrument to be operated is a 200F Series Flow Controller, refer to Figure 3-2 and Table 3-2, the counterparts of those listed for the flowmeter.

Make the connections to socket J2 in accordance with the appropriate diagram previously noted. A separate control valve common wire (pin B, J2) is highly recommended. This connection keeps the high current related to the control valve independent of the more sensitive, low level, processing circuitry, thus avoiding potential noise problems and/or ground loops. For replacement applications, where the wiring already exists, it may not be feasible to add the extra control valve common wire. If so, the valve common may be connected to signal common by jumper switch J6 located on the plug-in card and shown as part of Figure 3-2. Use of this jumper, however, may add some degree of error to the flow signal, since the valve drive current must now be carried by the signal common and will generate a voltage drop proportional to valve current, wire resistance and length.

Note the circuit arrangement in Figure 3.2 for the set-point control. Not only does this configuration do away with the separate +5 Vdc power supply called for with earlier wiring configurations, but it also permits viewing of the set-point on the digital process meter, as well as the flow rate. Switch SW-1 is a spring return, SPDT push-button type, which causes the flow rate to be displayed under normal conditions and the set-point valve to be viewed when it is depressed.

Valve Override for Series 200F Flow Controllers

After wiring has been completed as described in the previous paragraphs, it may be well to consider certain valve override options. Although Soft Recovery Valve Override is preferred (refer to System Features, Section 1 for SRVO advantages), simple valve override functions have been included for replacement applications, where the existing wiring harness does not include the extra wires required to effect SRVO control. For simple close valve override action pin D, J2 is shorted to pin B, J2. For simple open valve override action, short pin B, J2 to pin 5, J2.

For SRVO close valve override operation, short pin L, J2 to circuit common (pins 2 or C, J2). In some replacement applications where a competitive model instrument may have been employed, shorting pins L and 10 together may have been specified for simple close valve override operation. By activating Jumper switch J5 (see Figure 3.2) close valve override operation between pins L and 10 may be retained, but with SRVO operation rather than simple operation!

For SRVO open valve override operation short pin 9, J2 to circuit common (pins 2 or C) on J2.

Electrical Interfacing Data

When digital logic ICs, such as TTL or CMOS gates or drivers, etc., are used to interface an external computer/controller with the 200F Flow Controller, it is important to observe the logic level values required for proper and reliable operation. Detailed listings for these values may be found in Appendix A of Section 7.

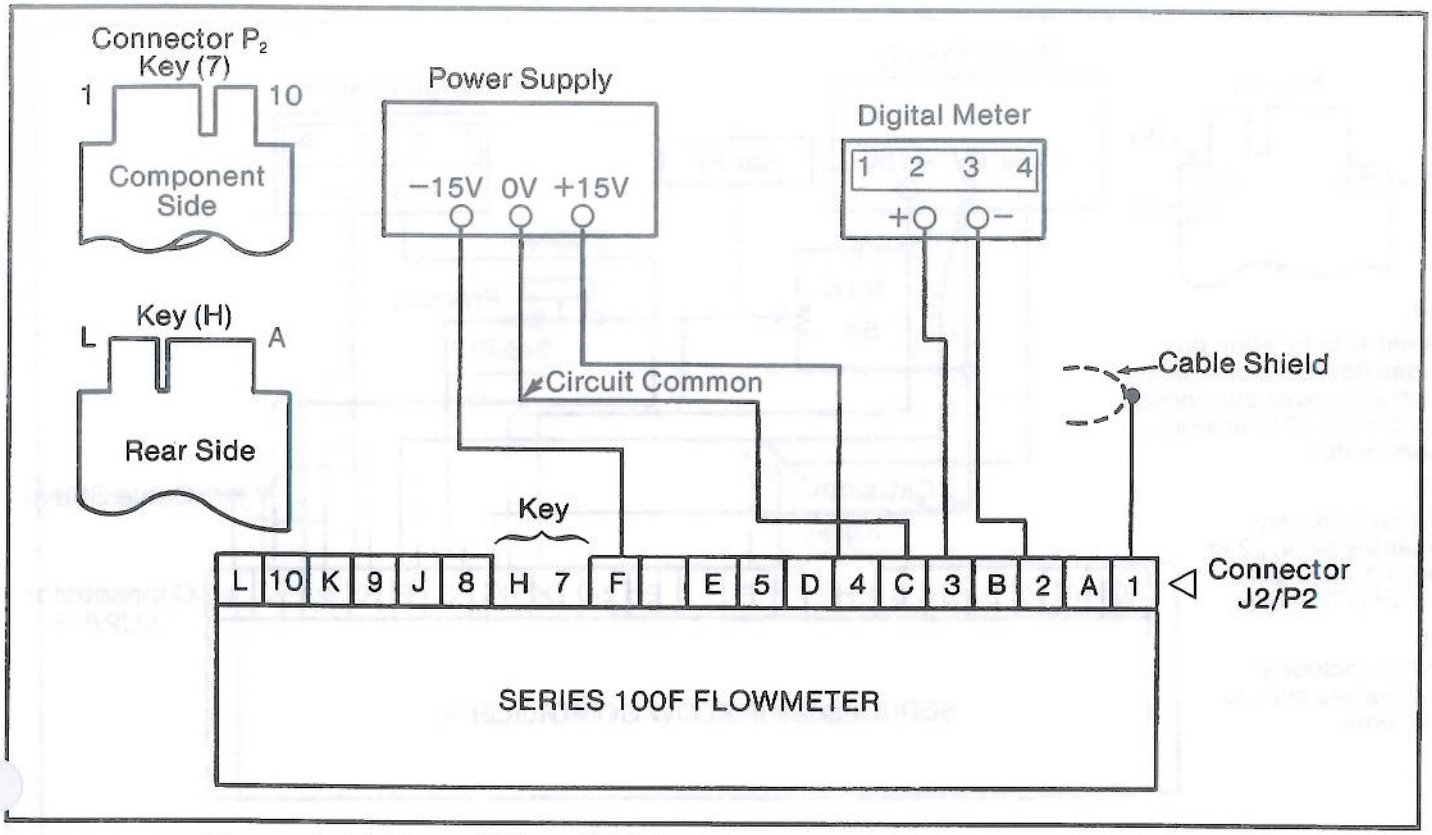


Figure 3-1. External Electrical Connections for Series 100F Flowmeter

Table 3-1. Functions by Pin Number of Connector J2/P2 for Series 100F Flowmeter

PC CARD PIN NO.	FUNCTION
1	Cable Shield
2	Circuit Common (with pin C)
3	Flow Signal Output (to Meter or Control System)
4	+15 Vdc Power Input
5	—
6	—
7	Key
8	—
9	—
10	—
A	—
B	—
C	Circuit Common (with pin 2)
D	—
E	—
F	−15 Vdc Power Input
H	Key
J	—
K	—
L	—

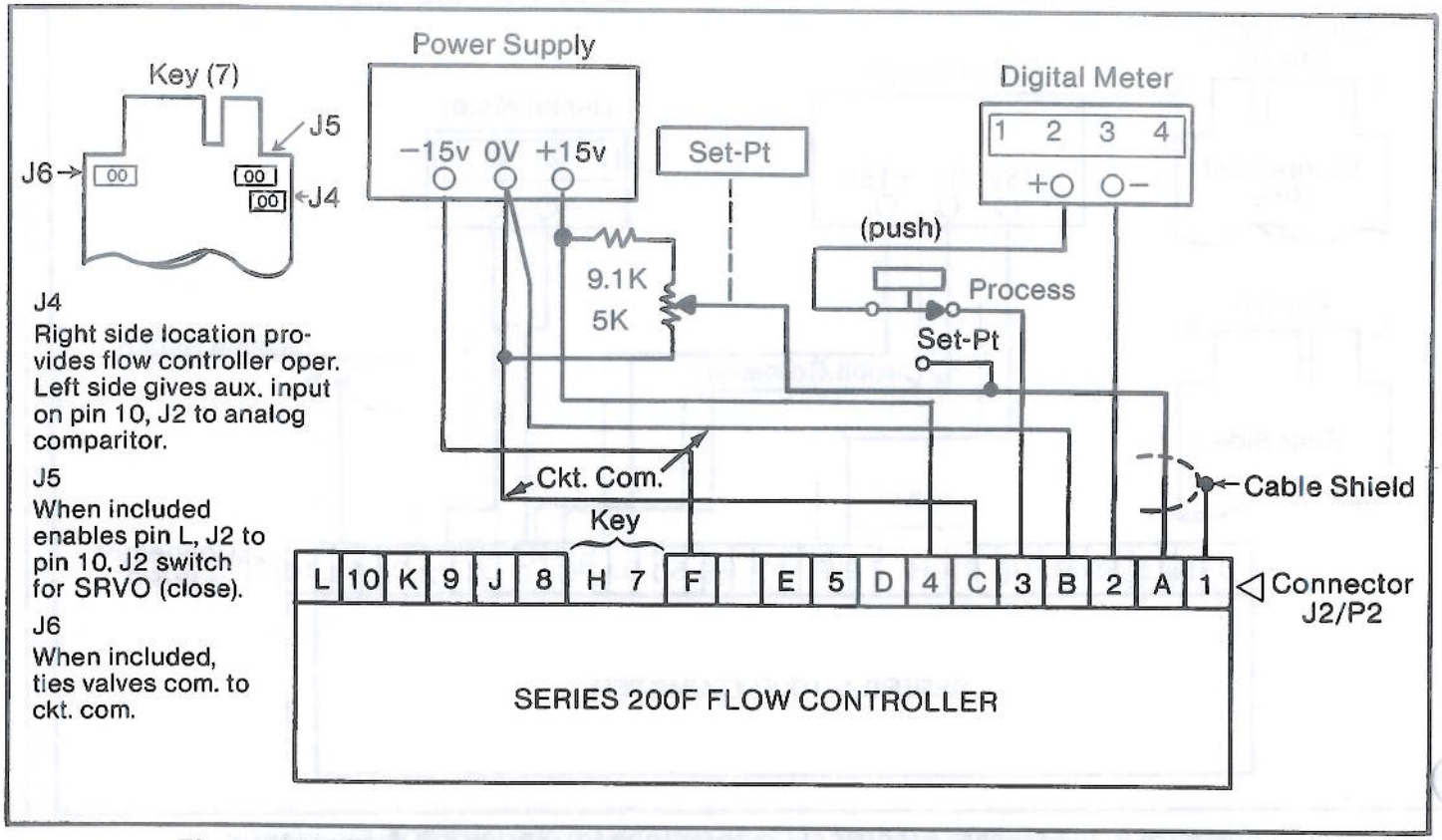


Figure 3-2. External Electrical Connections for Series 200F Flow Controller

Table 3-2. Functions by Pin Number of Connector J2/P2 for Series 200F Flow Controller

PC CARD PIN NO.	FUNCTION
1	Cable Shield
2	Circuit Common (with pin C)
3	Flow Signal Output (to Meter or Control System)
4	+15 Vdc Power Input
5	Sim-V0 (open) Input
6	—
7	Key
8	—
9	SRVO (open) Input
10	Aux. Input to Comp. or jumper switch (see J4)
A	Set-point Input (0 to 5 Vdc)
B	Valve Common
C	Circuit Common (with pin 2)
D	Sim-V0 (close) Input
E	—
F	−15 Vdc Power Input
H	Key
J	—
K	—
L	SRVO (close) Input

Cleaning

If the instrument and control valve have been subjected to severe contamination, they may require disassembly for effective cleaning. If the laminar flow device requires changing or replacement, accurate volumetric calibration facilities are required for recalibration of the instrument. When disassembling the instrument, do not attempt to remove the flow sensor bypass element.

Proceed with the following steps for disassembly of the flowmeter/flow controller.

a. Unscrew and remove the inlet fitting.
b. Loosen and remove the circlip spring.
c. Remove the coil spring, laminar flow element and O-ring. Do not attempt to further disassemble the laminar flow element.
d. Clean or replace parts as required, reassemble, and recalibrate.

Control Valve Disassembly

The following steps explain how to disassemble the control valve for cleaning or service:

a. If the valve is integral with the controller, disconnect the electrical connector.
b. Remove the hex nut from the top of the valve assembly and carefully remove the cover/coil assembly.
c. Unscrew the stem and remove.
d. Remove plunger assembly.
e. Unscrew and remove the orifice.
f. Parts may be cleaned ultrasonically, in freon or other suitable solvent. Stem and orifice O-rings should be replaced with new identical size and elastomer O-rings prior to reassembly. A replacement O-ring kit is available from Porter Instrument Company Inc.

System Purging

If corrosive gases or reactive gases such as silane are to be metered, the complete system must be purged to remove all air before introducing process gas into the system. Purging can be accomplished with dry nitrogen or other suitable inert gases.

Also, if it becomes necessary to break any gas connection, exposing the system to air, all traces of corrosive or reactive gas must be purged from the system *before* breaking the connection.

Operating Adjustments

Set system Power switch to ON. For Series 200F instruments, adjust SET-POINT to zero flow rate. Allow a 10 minute warm-up prior to operation. Next, turn-on the supply of gas to be monitored/controlled. You are now ready to proceed with required operating functions.

Establishing a Controlled Flow Rate

To operate the instrument at a desired flow rate, and the circuit shown in Figure 3-2 is used, press the push-button switch shown in Figure 3-2. It is recommended that this switch be labeled PROCESS/SET-POINT. The digital flow rate meter will now display the flow rate as determined by the SET-POINT Control. Adjust this control until the meter reads the desired flow rate. Releasing the push-button switch will cause the meter to display the process flow rate, which should change to the set-point value in a very short period of time.

Valve Override Functions

Remember, there are two sets of valve override functions employed by Series 200F Flow Controllers. Newer control systems feature Soft Recovery Valve Override (SRVO), where as older systems used simple valve override (Sim-VO) operation (refer to System Features, Section 1 for details). Electrical connection details were covered earlier in this section. Whether push-button switches are used or digital logic ICs are used to interface a computer/controller to the 200F Flow Controller, control action is identical. The valve operates per the designated function when the switch or digital logic output to the appropriate input is at the circuit common level.

If mechanical switches are used rather than digital logic ICs to provide the control functions noted above, push-button types should be chosen. If toggle types are used, they should have a second set of contacts which are connected to a source of power and a VALVE STATUS indicator light. When illuminated, this indicator will remind the operator that the override switch must be turned to return to automatic control operation. Note, mechanical switch contacts should be of a type appropriate for use in "dry" circuit applications. These contacts are usually gold or gold plated.

Return Shipments

Contact Porter Instrument Company Inc. for a Return Authorization Form if an item is to be returned for any reason. This form must accompany all return shipments. If the instrument was used with corrosive or toxic gases, the customer is responsible for removing all traces of hazardous materials prior to shipment. Porter Instrument Company Inc. is to be notified about conditions under which the instrument saw service before any instrument will be serviced. Items must be properly packed and shipped prepaid.

SECTION 4

THEORY OF OPERATION

Is it any wonder that the basic principles of the Mass Flowmeter are often misunderstood? The actual measurement being made is one of differential temperature change. Yet the readout is supposed to be a value of mass flow. However, the units are volumetric, not mass! Does any of this make sense? The answer is yes if you consider all of the scientific facts in the overall scheme of operation.

Measurement Factors

The basic measurement being made relates to the amount of heat absorbed by the gas being monitored. The molecular structure of the gas determines the amount of heat it absorbs. The thermodynamic property of specific heat quantitatively describes this "thermal absorbancy". Specific heat defines the amount of heat required to raise the temperature of a particular gas one degree centigrade. Therefore, the measurement also relates to specific heat. This thermal property, within the normal operating limits of the instrument, is essentially independent of temperature and pressure. In other words, a temperature change of 75 to 76°F is no different than one of 104 to 105°F. Likewise, it does not matter if the gas pressure is 10 psi or 100 psi., the value of specific heat remains unchanged.

Three important factors have been noted thus far: heat input (Q), specific heat (Cp) and temperature rise (Δt). These three factors possess a precise relationship to the mass flow (M). Therefore, accurate temperature measurement will produce an accurate indication of flow rate for a particular gas. Once a given flow rate has been defined, it is arbitrary and unimportant whether we choose mass or volumetric units. Calibration, of course must be based on the value of specific heat of the monitored gas.

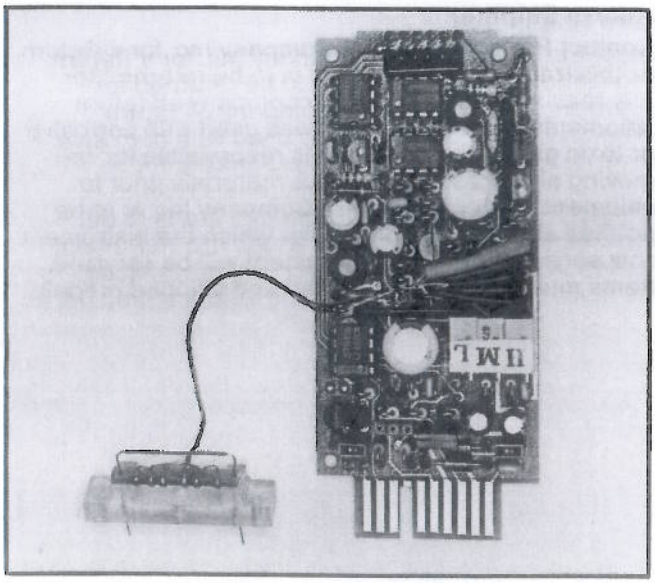


Figure 4-1. Sensor Assembly and Electronic Circuit Card

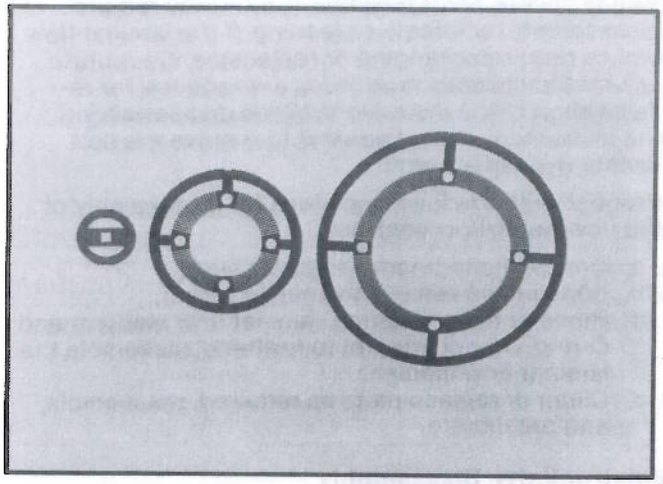


Figure 4-2. Flow Restrictor Elements

Front End Components

The heart of the sensing system consists of a capillary tube with two precision resistance type temperature sensors located on each side of a heater which is at the center of that same tube. Both sensors and heater are connected to a plug-in electronics printed circuit board via a miniature flexible cable. These components are shown in figure 4-1. A restrictor device located in the main gas flow path, divides the flow so that a fixed percentage of the gas will flow through the sensor tube. The restrictor is made up of disc-like wafers which control the total amount of flow. Depending upon the flow range desired, these disks may number between one and seventy-two. Each wafer has chemically milled precision slots or channels to restrict flow. Figure 4-2 illustrates three sizes of these wafers. Note that the smallest one shown has only one milled slot. This particular disc would be used as part of a restrictor in a low flow rate range instrument.

Wafers with more slots, more stacked together, larger size, or combinations would be used for different flow rate range instruments. A multiple wafer stack provides a large number of parallel paths for gas flow, thereby offering a higher flow rate.

Restrictor and Sensing Action

Understanding how these components utilize the previously discussed thermodynamic theory requires an inspection of how each component works and how they relate to one another. By placing an appropriate restrictor in the main flow path, a pressure drop is created which forces approximately 10 cubic centimeters of flow through the capillary sensor tube. More specifically, if the full scale range of the unit in question was one liter (1000 cc), 10 cc would flow through the sensor tube and 990 cc would flow through the restrictor located in the main channel. Figure 4-3 illustrates a block diagram of the sensor system.

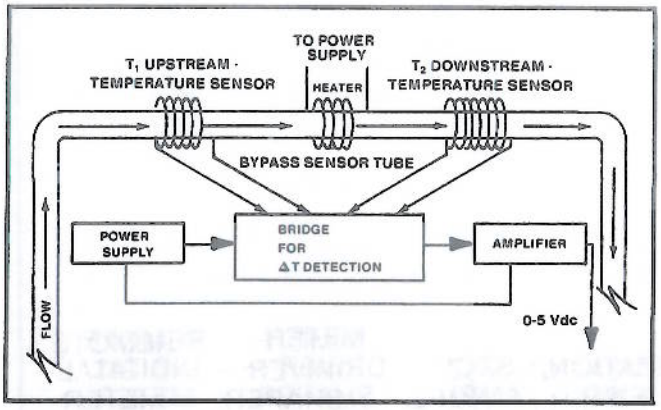


Figure 4-3. Block Diagram of Flow Sensor System

Heat from the heater spreads out uniformly from the center of the sensor tube. Gas flowing in this tube begins to absorb heat in the area of temperature sensor 1. The gas gains maximum heat as it passes through the heater or center area. As it emerges from this area it gives up some of its heat at temperature sensor 2's location. However, it always has a higher temperature at the second sensor than it did at the first sensor. These temperature sensors form two legs of a bridge network at the sensor inputs to the plug-in electronics card.

To ensure an accurate flow measurement, any variables must be eliminated or grossly reduced. For example, turbulent flow is not allowed. Accordingly, both sensor tube and restrictor are designed for laminar flow.

Flowmeter/Controller Electronics

As noted in section 1, the electronics card performs three general flowmeter functions: amplification, linearization and output meter drive. If the instrument in question is a flow controller, additional control circuitry is included on the card to regulate a control valve. See Figure 4-4 for the block diagram of the Porter Series 200F Flow Controller. Let's trace the signal through each block to better understand the measurement and control functions.

For a condition of no gas flow, both temperature sensors are heated equally and have the same resistance values. This means the bridge circuit is balanced and the difference in voltage between each sensing leg of the bridge is zero. Meter output reading at this time is also zero. When gas flow does occur, the downstream temperature sensor increases its resistance with respect to temperature sensor 1. Therefore a differential voltage is developed which is directly proportional to mass flow rate of the gas. This differential signal, typically about 30 millivolts maximum, is applied to the input of a precision, high gain, two stage differential amplifier. The amplified signal is then fed to a single stage linearization amplifier. The degree of correction is small, since a subtle non-linearity effect takes place as the flow rate approaches its full range value.

Output signal from the linearization stage drives a special signal conditioning amplifier which provides Porter's exclusive Stable Zero Control (SZC) feature. In general, signals which approach zero volts may tend to be not well defined due to possible drift or variation in amplification. In some designs the signal may even cross over the zero line into the negative voltage region. This problem is eliminated in the Porter Instruments' SZC circuit because the low voltage limit is never less than +0.3% of full scale (see System Features in Section 1).

Signal from the SZC stage is applied to the output meter driver/shaper stage. This dual purpose stage is called an active differentiator network, which has a tailored rapid response characteristic. In less technical language, the "peaked" response of the stage causes the slower changing flow signal to change in the same manner as the actual gas flow changes. Figure 4-5 shows how this circuit's signal closely duplicates a rapid step change in gas flow rate. The second purpose of this stage is to provide a 0 to 5 volt DC output for 0 to 100 percent flow rate, which is used to drive a digital flow rate meter.

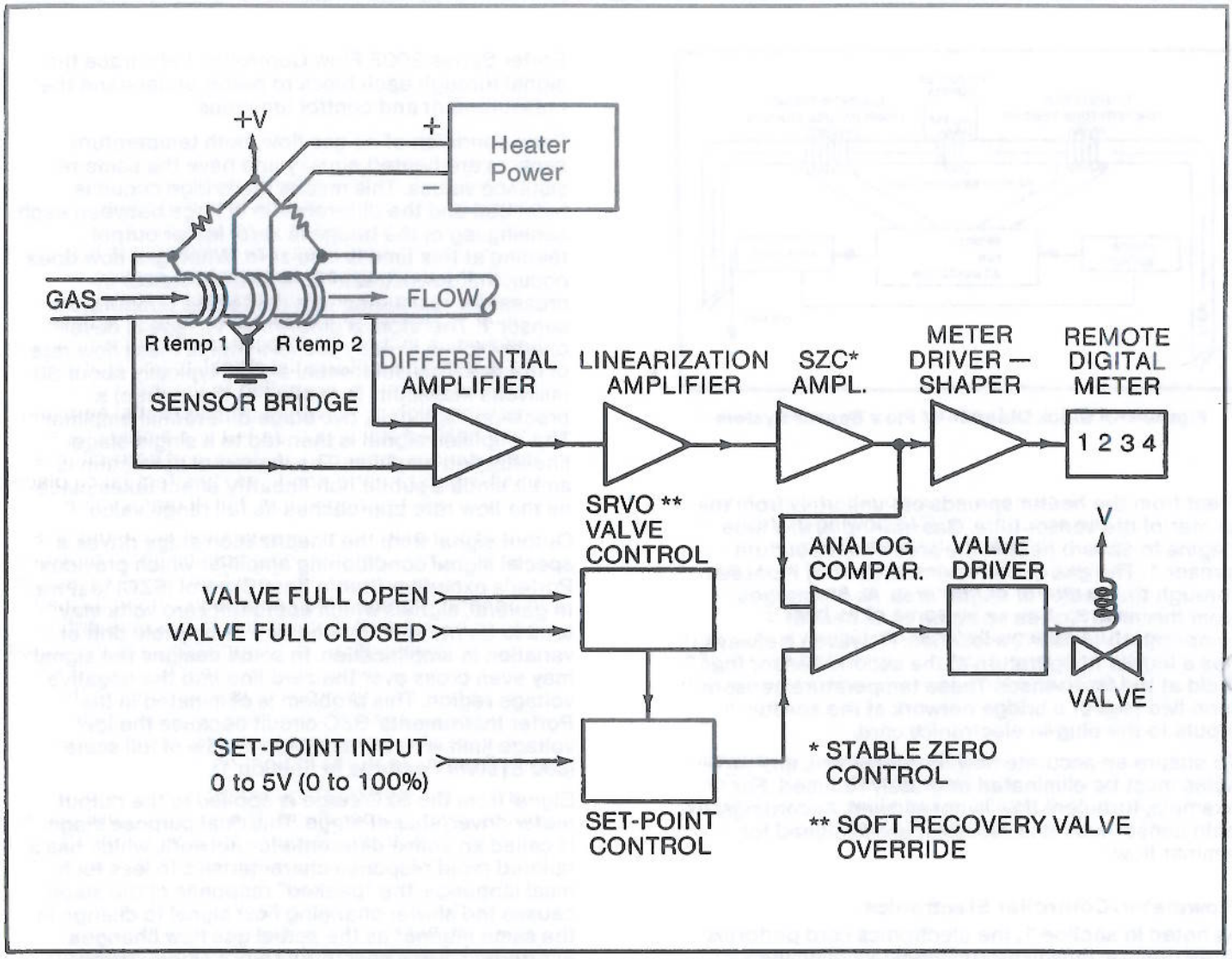


Figure 4-4. Block Diagram of 200F Series Flow Controller

Control of the Proportional Valve

Closed loop control of the proportional control valve adds several functional blocks to the flow controller electronics diagram which are not found in the one for the flowmeter. Those functions include: a set-point input channel, an analog comparitor, and a valve (power) driver stage. Generally speaking, the system works as follows: the set-point input signal (0 to 5 Vdc) is compared with the gas flow signal in the analog comparitor stage. If the set-point signal is "calling" for decreased flow, the comparison between these two signals is such that the comparitor applies a signal of a given magnitude and polarity to the valve driver stage which causes the valve to begin to close. As this occurs, the gas flow signal approaches and ultimately equals the voltage of the set-point signal. At this time the valve's power drive signal has stabilized, holding the valve firmly in that position.

It is important to understand some of the specific details of the previously described control function. A resistance-capacitance filter network is employed in the set-point channel which is factory adjusted to match the thermal time constant of the temperature sensors.

Such signal tailoring causes accurate set-point/gas flow rate tracking when the set-point is abruptly readjusted. Two additional circuits are included as part of the set-point channel. One holds the control valve full open, the other holds it full closed as a result of external command signals. Together they form Porter's exclusive Soft Recovery Valve Override (SRVO) function. This feature (see System Features in Section 1) provides smooth, non-overshoot control under worst case conditions and protects the control valve.

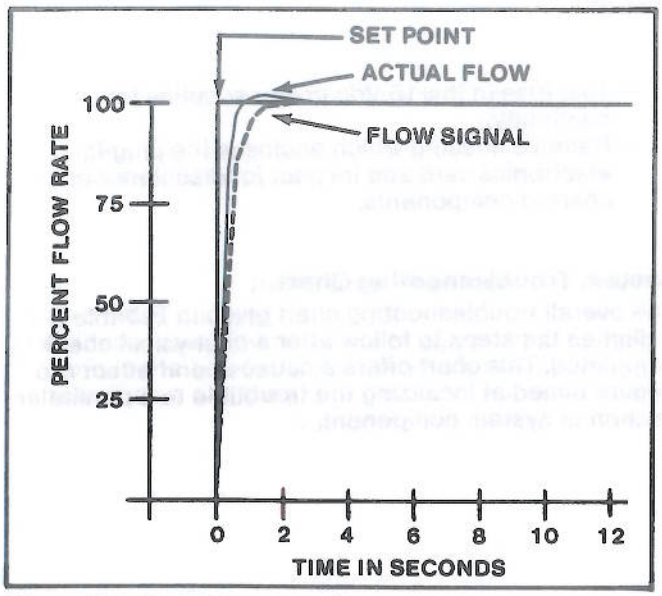


Figure 4-5. Rapid Response Curve: Comparison between Flow Signal and Actual Gas Flow

Recalling the basic explanation given in Section 1 of a closed loop control system, control action is effected in two ways. When flow tends to change for whatever reason or influence, the corresponding change in flow rate signal causes a change in valve displacement in a direction appropriate to maintain flow rate constant. In other words, valve action is inversely proportional to flow rate distrubances. When the set-point signal is changed, the difference between flow rate signal and set-point causes the analog comparitor to generate an error signal which forces the control valve to a new setting. It will remain there when the control system stabilizes and the error signal becomes zero. Typical valve displacement or travel, for an instrument sized for 1 slm nitrogen and an inlet/outlet pressure drop of 20 psi, is approximately 0.003 inch for 0 to 100 percent flow rate.

SECTION 5

MAINTENANCE

General

Successful maintenance and troubleshooting depends upon the ability of the operator or technician to associate a given symptom with the source of problem. The more familiar one is with the workings of the instrument, the easier it is to make this association. Carefully reading the Theory of Operation section (section 4) is one good way to gain this familiarity. Also this knowledge will help in formulating troubleshooting procedures for less common problems. The potential problems described in this section are, of necessity, more general in nature.

Preliminary Checks

When no specific cause of trouble is apparent, a good preliminary check is to make a visual inspection of the instrument in the following areas:

- Check cables for loose or broken wires.
- Inspect cables for loose fit.
- Test fuse in the 15 Vdc power supplies for continuity.
- Remove housing which encloses the plug-in electronics card and inspect for discolored or charred components.

System Troubleshooting Chart

The overall troubleshooting chart given in Table 5-1 indicates the steps to follow after a physical check is completed. This chart offers a cause and effect procedure aimed at localizing the trouble to a particular section or system component.

Table 5-1, System Troubleshooting Chart

Symptom	Possible Cause	Corrective Action
No output	No power input	Check power supply with cable in place for +/− 15 Vdc at socket J2. Check power supply line fuse.
Signal offset at zero flow	Digital display meter shifted upscale	Check by shorting input to display meter (with pin 3, J2 open), or by depressing PROCESS/ SET-PT switch SET-POINT control at zero.
Signal offset at zero flow (cont.)	Electronics plug-in card out of calibration	See Calibration, section 6.
Signal offset	Gas leak (Flowmeter)	Check downstream gas connections. Check seals in Flowmeter and valve.
	Valve oscillates	Insufficient pressure drop Increase supply pressure.
Valve oscillates	Excessive pressure drop	Lower supply pressure.
	"Jumpy" supply pressure	Replace upstream pressure regulator.
	Valve stem loose	Tighten valve stem.
Flow indication "pegged" (saturated) up or down scale	Bridge or sensor failure (e.g. sensor open)	Return to factory for repair.
Flow indication appears to be erroneous	Digital display meter	Check display meter against standard voltmeter at pin 3,J2 to circuit common. (e.g. full scale display should equal 5.0 Vdc on voltmeter).
	Change in composition of metered gas	Check gas supply.
	Gas leaks (Flowmeter)	Check downstream connections. Check O-ring seal of laminar flow device.
	Drift or shift in electronics plug-in card	Replace with spare card. Recalibrate.

SECTION 6

CALIBRATION

General

All of Porter Instrument's Series 100F Flowmeters and Series 200F Flow Controllers are shipped precalibrated within the tolerances given in the Specification, Section 1. These values should be maintained for many years under normal conditions. However, if service is ever required, or if PC card components are replaced, recalibration may be required.

Equipment Required

To verify or establish specified flow rate values, an accurate volumetric calibration device is required. Do not use a rotameter or similar device, as its accuracy is not sufficient for calibration of the mass flowmeter or controller. Normally a digital voltmeter (0.1 percent accuracy or better) is also required. However, the digital process meter, used as a readout device, may be substituted, since it measures 0 to 5 Vdc at comparable accuracy, and its calibration should not be in question.

Calibration Procedure

To calibrate 100F Series or 200F Series instruments, proceed as outlined in the steps that follow.

For 100F Series:

a. Remove the cover to gain access to the plug-in card.
b. Apply power and allow 10 minutes for system warm up and stabilization.
c. Slowly introduce gas flow into the system.
d. Connect the voltmeter to the output signal, pin 3 of J2.
e.

Step	Set Gas Flow (vol. cal. device)	Adjust Trimpot	Flow Signal Output (volts at J2, pin 3)
1	50%of range	M	2.500
2	100% of range	H	5.000
3	0% of range	L	0.025 ± 5mV

f. Repeat steps 1 through 3 above until the deviations between the desired values and the adjusted values are less than 0.2% FS. Note that trimpots H and L can be adjusted without re-requiring adjustment of M or each other. However, adjustment of M does require readjustment of trimpots H and L.

For 200F Series:

a. Remove the cover to gain access to the plug-in card.
b. Adjust SET-POINT input to 0 Vdc (0%).
c. Apply power and allow 10 minutes for system warm up and stabilization.
d. Adjust SET-POINT input to >+5.100 Vdc (102%).
e. Slowly introduce gas flow into the system.
f. Connect the voltmeter to the output signal, pin 3 of J2.
g.

Step	Set Gas Flow (vol. cal. device)	Adjust Trimpot	Flow Signal Output (volts at J2, pin 3)
1	50%of range	M	2.500
2	100% of range	H	5.000
3	0% of range	L	0.025 ± 5mV

h. Repeat steps 1 through 3 above until the deviations between the desired values and the adjusted values are less than 0.2% FS. Note that trimpots H and L can be adjusted without requiring readjustment of M or each other. However, adjustment of M does require readjustment of trimpots H and L.

A graph of Output Voltage vs. Percent Flow showing the transfer area affected by trimpots L, M, and H is illustrated in Figure 6-1.

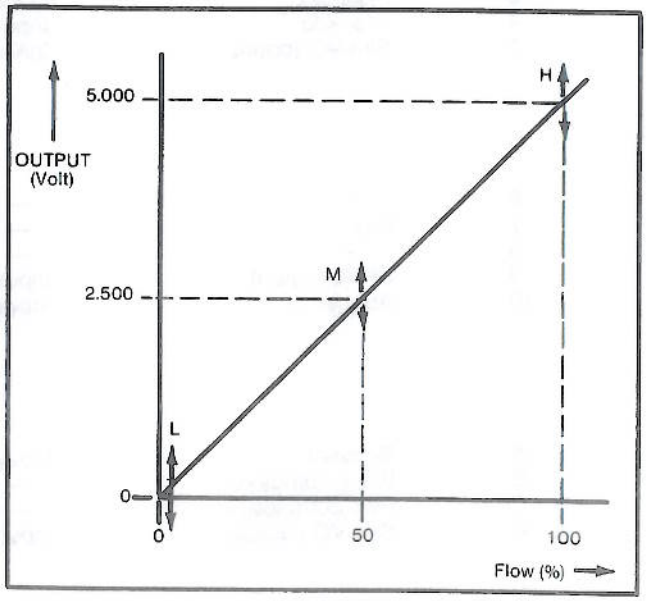


Figure 6-1. Flow Signal Output vs. Percent Actual Flow: Trimpots, L, M, and H areas of influence.

SECTION 7

I/O DESIGNATIONS (Electrical Connections)

MASS FLOWMETER (Series 100F)

P.C. BD. CONTACT	NAME/FUNCTION	INPUT/ OUTPUT	COMMENTS
1	Shield	—	
2	F.S. Ret.	Output	Flow signal return (sig. common)
3	Flow Sig.	Output	0 – +5 volts
4	+15 Vdc	Input	Power in
5	—	—	
6	—	—	
7	Key	—	Connector keying slot
8	—	—	
9	—	—	
10	—	—	
A	—	—	
B	—	—	
C	Pwr. Common	—	Power com.
D	—	—	
E	—	—	
F	–15 Vdc	Input	Power in
H	Key	—	Connector keying slot
J	—	—	
K	—	—	
L	—	—	

MASS FLOW CONTROLLER (Series 200F)

P.C. BD. CONTACT	NAME/FUNCTION	INPUT/ OUTPUT	COMMENTS
1	Shield	—	
2	F.S. ret.	Output	Flow signal return (sig. common)
3	Flow sig.	Output	0 – +5 volts
4	+15 Vdc	Input	Power in
5	Sim-VO (open)	In/Out	Dual function; as input — used as a simple valve override (open), NOT RECOMMENDED FOR NEW SYSTEM DESIGN as output — valve voltage test pt.
6	—	—	
7	Key	—	Connector keying slot
8	—	—	
9	SRVO (open)	Input	Logic level valve override; low true
10	Aux. in	Input	dual function; logic level valve return — internal jumper switch J5 must be in position 1 aux. in — internal jumper switch J5 must be in position 2
A	Setpoint	Input	0 – +5 volts
B	Valve common	—	Isolated valve power com.
C	Pwr. common	—	Power com.
D	Sim-VO (close)	Input	NOT RECOMMENDED FOR NEW SYSTEM DESIGN
E	—	—	
F	–15 Vdc	Input	Power in
H	Key	—	Connector keying slot
J	—	—	
K	—	—	
L	SRVO (close)	Input	Logic level valve override; low true

I/O ELECTRICAL SPECIFICATIONS
(Note — Values typical unless otherwise noted)
MASS FLOWMETER (Series 100F)

+15 Vdc	
Voltage limits — max	+16.5v
— min	+11.4v
Current	<25 ma
-15 Vdc	
Voltage limits — max	–16.5v
— min	–13.5v
Current	<25 ma
Flow Signal	
Output voltage	+.025v to +5v for 0 to 100% f.s. flow
Output current limit	4 ma nom.
External load resistance	2 k min. (ref. to sig. common)
Common ref.	Sig. common

I/O ELECTRICAL SPECIFICATIONS
(Note — Values typical unless otherwise noted)
MASS FLOW CONTROLLER (Series 200F)

+15 Vdc	
Voltage limits - max	+16.5v
- min	+11.4v
Current	<25 ma
−15 Vdc	
Voltage limits - max	−16.5v
- min	−13.5v
Current - 0% flow	<25 ma
- 100% flow	<175 ma
- valve full open	<300 ma
Flow Signal	
Output Voltage	+.025v to +5v for 0 to 100% f.s. flow
Output current limit	4 ma nom.
External load resistance	2k min. (ref. to signal common)
Common ref.	Sig. common
Setpoint	
Input voltage	
normal	0v to +5v for 0% to 100% flow control
Limits	−5v to +6.5v
Input current	
V_{in} =+5v	<+6 microamp
+5v, SRVO (close) = 0v	+500 microamp
0v, SRVO (open) = 0v	<−600 microamp
0v, SRVO (open & close) = 0v	<+1 microamp
Input impedence	>900 k ohm, approx. .01 mF
Common ref	Sig. common
Soft Recovery Valve Override Control (SRVO open and close)	
Input voltage	
Absolute max.	+15v, −5v
Enable threshold	<+0.8v
Disable threshold	>+2.8v
Recommended logic levels	0v, +5v
Logic level compatibility	TTL, LPTTL, LPSTTL, CMOS, HLL
Input current	
SRVO (open) −	
for V_{in} = +15.0v	+1.8 ma
+5.0v	+320 microamp
0v	−480 microamp
− 5.0v	−1.4 ma
SRVO (close) −	
for V_{in} = +15.0v	+1.8 ma
+ 5.0v	+260 microamp
0v	−430 microamp
− 5.0v	−770 microamp
Aux. In	
Input voltage range	
Absolute max.	+/− 10v
Normal	0 to +5v
Input resistance	2.2 megohm

GAS CONVERSION FACTORS

Flowmeters and flow controllers are shipped from the factory calibrated for use with a specific gas. The original calibration conditions are stated on the serial tag attached to the top of the p.c. board cover.

If it is desired to use a flowmeter or controller with a gas other than the original calibration gas, the following calculation is necessary:

Select the conversion factor for each gas from the chart. Multiply the output reading by the ratio of the conversion factor for the desired gas to the conversion factor for the calibration gas.

Example:
Meter calibrated on N_2 (200 cc/min.)
Gas flow passing the meter is CO_2
Output signal is 80.0% (4V)

$$\text{Actual } CO_2\text{-flow} = 80.0 \times \frac{0.745}{1.000} = 59.6\%$$

$$\text{or } \frac{59.6}{100} \times 200 = 119.2\text{cc/min.}$$

Gas	Symbol	Conversion factor	Specific heat C_p at 25° and 1 atm. kcal/kgK	Density at 0° and 1 atm. kg/m³
Acetone	C_3H_6O	0.340		
Acetylene	C_2H_2	0.602	0.391	1.162
Air	–	1.000	0.240	1.293
Allene (Propadiene)	C_3H_4	0.43	0.352	1.787
Ammonia	NH_3	0.73	0.492	0.760
Argon	Ar	1.443	0.1244	1.782
Arsine	AsH_3	0.662	0.1167	3.478
Boron Trichloride	BCl_3	0.41	0.1279	5.227
Boron Trifluoride	BF_3	0.51	0.1778	3.025
Bromine	Br_2	0.81	0.0539	7.130
Bromine Pentafluoride	BrF_5	0.26	0.1369	7.803
Bromine Trifluoride	BrF_3	0.38	0.1161	6.108
Bromo Trifluoromethane (Freon-13 B1)	$CBrF_3$	0.37	0.1113	6.644
Butadiene	C_4H_6	0.32	0.3514	2.413
Butane	C_4H_{10}	0.26	0.4007	2.593
1-Butene	C_4H_8	0.295	0.3648	2.503
2-Butene (Cis)	C_4H_8	0.324	0.336	2.503
2-Butene (Trans)	C_4H_8	0.291	0.374	2.503
Carbon Dioxide	CO_2	0.745	0.2016	1.964
Carbon Disulfide	CS_2	0.60	0.1428	3.397
Carbon Monoxide	CO	1.001	0.2483	1.250
Carbon Tetrachloride	CCl_4	0.309	0.1655	6.860
Carbonyl Fluoride	COF_2	0.544	0.1710	2.045
Carbonyl Sulfide	COS	0.64	0.1651	2.680
Carbon Tetrafluoride	CF_4	0.42	0.1654	3.926
Chlorine	Cl_2	0.852	0.1144	3.163
Chlorine Trifluoride	ClF_3	0.403	0.1650	4.125
Chloro Difluoromethane (Freon-22)	$CHClF_2$	0.456	0.1544	3.858
Chloroform	$CHCl_3$	0.388		
Chloro Pentafluoro-ethane (Freon-115)	C_2ClF_5	0.24	0.164	6.892
Chloro Trifluoro-methane (Freon-13)	$CClF_3$	0.38	0.153	4.660
Cyanogen	C_2N_2	0.44	0.2613	2.322
Cyanogen Chloride	ClCN	0.61	0.1739	2.742
Cyclopropane	C_3H_6	0.460	0.3177	1.877
Deuterium	D_2	1.003	1.722	0.1799
Diborane	B_2H_6	0.434	0.508	1.235
Dibromo Difluoro-methane	CBr_2F_2	0.19	0.15	9.362
Dichloro Difluoro-methane (Freon-12)	CCl_2F_2	0.354	0.1432	5.395
Dichloro Fluoromethane (Freon-21)	$CHCl_2F$	0.417	0.140	4.592
Dichloro Methyl Silane	$(CH_3)_2SiCl_2$	0.25	0.1882	5.758
Dichloro Silane	SiH_2Cl_2	0.40	0.150	4.506
1,2-Dichloro Tetrafluoro-ethane (Freon-114)	$C_2Cl_2F_4$	0.22	0.160	7.626
1,1-Difluoro Ethylene (Freon-1132A)	$C_2H_2F_2$	0.43	0.224	2.857
Dimethylamine	$(CH_3)_2NH$	0.370	0.366	2.011
Dimethylether	$(CH_3)_2O$	0.390	0.3414	2.055
2,2-Dimethylpropane	C_5H_{12}	0.22	0.3914	3.219
Ethane	C_2H_6	0.497	0.4097	1.342
Ethanol	C_2H_6O	0.39	0.3395	2.055
Ethyl Acetylene	C_4H_6	0.32	0.3513	2.413
Ethylchloride	C_2H_5Cl	0.40	0.244	2.879
Ethylene	C_2H_4	0.622	0.351	1.252
Ethylene Oxide	C_2H_4O	0.52	0.268	1.965
Fluorine	F_2	0.978	0.1873	1.695
Fluoroform (Freon-23)	CHF_3	0.506	0.176	3.127
Freon-11	CCl_3F	0.34	0.1357	6.129
Freon-12	CCl_2F_2	0.34	0.1432	5.395
Freon-13	$CClF_3$	0.383	0.153	4.661
Freon-13 B1	$CBrF_3$	0.36	0.1113	6.644
Freon-14	CF_4	0.41	0.1654	3.926
Freon-21	$CHCl_2F$	0.42	0.140	4.592
Freon-22	$CHClF_2$	0.438	0.1579	3.938
Freon-23	CHF_3	0.50	0.176	3.127
Freon-113	CCl_2FCClF_2	0.20	0.161	8.360
Freon-114	$C_2Cl_2F_4$	0.22	0.160	7.626
Freon-115	C_2ClF_5	0.24	0.164	6.892
Freon-116	F_3CCF_3	0.24	0.1843	6.157
Freon-C318	C_4F_8	0.17	0.185	8.397
Freon-1132A	$C_2H_2F_2$	0.43	0.224	2.857
Genetran-21	$CHCl_2F_4$	0.41		
Genetran-115	C_2ClF_5	0.24		
Germane	GeH_4	0.596	0.1404	3.418
Germanium Tetra-chloride	$GeCl_4$	0.27	0.1071	9.565
Helium	He	1.444	1.241	0.1786
3-Helium	$_3He$	1.45		
Hexafluoro-ethane	C_2F_6	0.24	0.1843	6.157
Hexane	C_6H_{14}	0.18	0.3968	3.845
Hydrogen	H_2	1.021	3.3852	0.0899
Hydrogen Bromide	HBr	0.985	0.0874	3.610
Hydrogen Chloride	HCl	0.998	0.1912	1.627
Hydrogen Cyanide	HCN	0.76	0.3171	1.206
Hydrogen Fluoride	HF	0.997	0.3479	0.893
Hydrogen Iodide	HI	0.999	0.5449	5.707
Hydrogen Selenide	H_2Se	0.78	0.1025	3.613
Hydrogen Sulfide	H_2S	0.799	0.2397	1.520
Iodine Pentafluoride	IF_5	0.25	0.1108	9.90
Isobutane	C_4H_{10}	0.26	0.3872	3.593
Isobutylene	C_4H_8	0.29	0.3701	2.503
Krypton	Kr	1.45	0.0593	3.739
Methane	CH_4	0.731	0.5223	0.716
Methanol	CH_3OH	0.583	0.3274	1.429
Methyl Acetylene	C_3H_4	0.43	0.3547	1.787
Methylamine	CH_5N	0.491		
Methyl Bromide	CH_3Br	0.56	0.1106	4.236
Methyl Chloride	CH_3Cl	0.63	0.1926	2.253
Methyl Fluoride	CH_3F	0.559	0.3221	1.517
Methyl Mercaptan	CH_4S	0.52	0.2459	2.146
Methyl Trichlorosilane	$SiCH_3Cl_3$	0.250	0.164	6.669
Molybdenum Hexa-fluoride	MoF_6	0.21	0.1373	9.366
Monoethylamine	$C_2H_5NH_2$	0.35	0.387	2.011
Monomethylamine	CH_3NH_2	0.45	0.4343	1.386
Neon	Ne	1.445	0.246	0.900
Nitric Oxide	NO	0.997	0.2328	1.339
Nitrogen	N_2	1.000	0.2485	1.250
Nitrogen Dioxide	NO_2	0.74	0.1933	2.052
Nitrogen Fluoride	NF_3	0.48	0.1797	3.168
Nitrosyl Chloride	NOCl	0.61	0.1632	2.920
Nitrous Oxide	N_2O	0.713	0.2088	1.964
Octafluorocyclobutane (Freon-C318)	C_4F_8	0.17	0.185	8.937
Oxygen	O_2	0.994	0.2190	1.428
Oxygen Difluoride	OF_2	0.63	0.1917	2.409
Pentaborane	B_5H_9	0.26	0.38	2.816
n-Pentane	C_5H_{12}	0.21	0.398	3.219
Perchloryl Fluoride	ClO_3F	0.39	0.1514	4.571
Performa-ethylene	C_2F_4	0.33		
Perfluoropropane	C_3F_8	0.17	0.194	8.388
Phosgene	$COCl_2$	0.44	0.1394	4.418
Phosphine	PH_3	0.76	0.2374	1.517
Phosphorus Penta-fluoride	PF_5	0.30	0.1610	5.620
Propane	C_3H_8	0.372	0.3735	1.967
Propylene	C_3H_6	0.405	0.3541	1.877
Silane	SiH_4	0.596	0.3189	1.433
Silicon Tetrachloride	$SiCl_4$	0.288	0.1270	7.580
Silicon Tetrafluoride	SiF_4	0.35	0.1691	4.643
Sulfur Dioxide	SO_2	0.687	0.1488	2.858
Sulfur Hexafluoride	SF_6	0.27	0.1592	6.516
Sulfuryl Fluoride	SO_2F_2	0.39	0.1543	4.562
Tetrafluorhydrazine	N_2F_4	0.32	0.183	4.640
Trichlorofluoromethane (Freon-11)	CCl_3F	0.33	0.1357	6.129
1,1,2-Trichloro-1,2,2-Trifluoro-ethane (Freon-113)	CCl_2FCClF_2	0.20	0.161	8.360
Tri-isobutyl Aluminium	$(C_4H_9)_3Al$	0.061	0.508	8.848
Trimethylamine	$(CH_3)_3N$	0.27	0.3710	2.639
Tungsten Hexafluoride	WF_6	0.25	0.0810	13.28
Uranium Hexafluoride	UF_6	0.20	0.0888	15.70
Vinyl Bromide	C_2H_3Br	0.46	0.1241	4.772
Vinyl Chloride	C_2H_3Cl	0.48	0.2054	2.788
Vinyl Fluoride	C_2H_3F	0.551		
Water Vapour	H_2O	0.817		
Xenon	Xe	1.41	0.0378	5.858

SECTION 9

ADDENDUM
FAST RESPONSE MASS FLOWMETER & CONTROLLER SERIES 100F & 200F

The following information explains the 9-pin, D-type electrical connector printed circuit board (PCB) assembly option available with Porter Instrument Co., Inc.'s Series 100F and 200F Mass Flowmeters (MFM's) and Mass Flow Controllers (MFC's), and is intended to supplement the text in the technical and users manual FM-369. **Please be aware the technical and users manual FM-369 was originally intended for use with the card edge electrical connector PCB assembly, therefore, references made to PCB pin numbers and other specifications are in reference to the card edge electrical connector.**

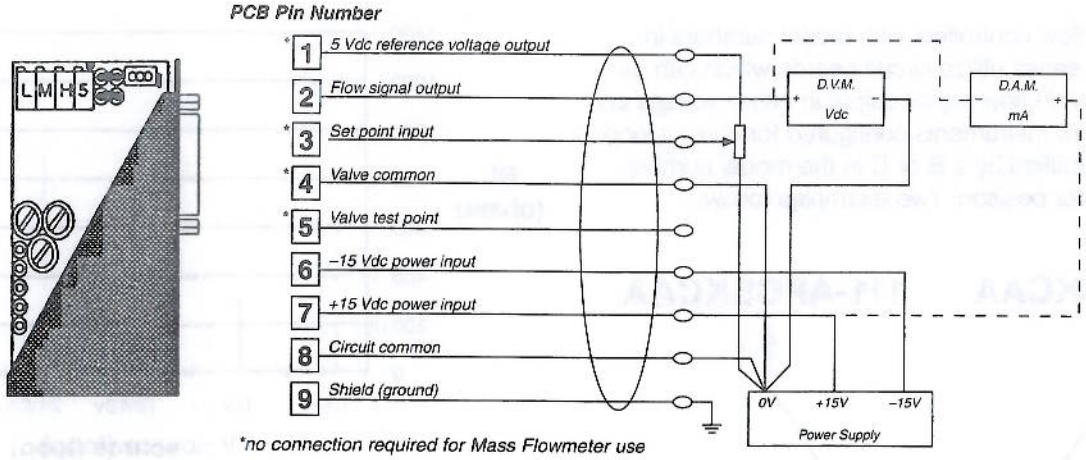
Specifications (refer to Section 2, page 2.1)

To supplement the performance specifications listed in FM-369, below are additional characteristics for the 9-pin, D-type electrical connector PCB assembly. Notes # 1, 2, and 3 also pertain to the card edge electrical PCB assembly.

1. Maximum Operating Pressure:
   - A. Mass Flowmeters:
     - Models 111, 112, 113 and 114 — 1500 PSIG
   - B. Mass Flow Controllers:
     - 1) Models 201, 202 and 251 — 1000 PSIG
     - 2) Models 202A, 203A and 204A — 200 PSIG
2. Mounting Orientation: Attitude Insensitive
3. Warm-up Time: 10 minutes
4. Output Signal Options:
   - A. 0-5 Vdc with 2K ohm minimum load impedance
   - B. 0-20 mAdc (non-floating/ground-referenced)
   - C. 4-20 mAdc (non-floating/ground-referenced)
5. Set Point Signal (required for MFC's only):
   - A. 0-5 Vdc (for MFC's supplied with either 0-5 Vdc or 0-20 mAdc output signal)
   - B. 1-5 Vdc (for MFC's supplied with 4-20 mAdc output signal)
6. Power Requirements:
   - A. Series 100F MFM's:
     - 1) +15 Vdc @ 75 mAdc
     - 2) –15 Vdc @ 25 mAdc
   - B. Series 200F MFC's:
     - 1) +15 Vdc @ 250 mAdc
     - 2) –15 Vdc @ 25 mAdc

External Electrical Connections (refer to Section 3, Pages 3.1 - 3.3)

Hook-Up Diagram



Calibration Procedure (refer to Section 6, page 6.1)

1. For Series 100F MFM's:
   - A. Same
   - B. Same
   - C. Same
   - D. Connect the voltmeter or ammeter, whichever is applicable, to the output signal, pin #2, of the MFM
   - E.

Step	Set Gas Flow (% of full scale)	Adjust Trimpot	0-5 Vdc (Vdc)	Flow Signal Output 4-20 mAdc (mAdc)	Flow Signal Output 0-20 mAdc (mAdc)
1	50	M	2.500	12	10
2	100	H	5.000	20	20
3	0	L	.025 (±0.005)	4.08 (±0.016)	0.10 (±0.02)

2. For Series 200F MFC's:
   - A. Same
   - B. Same
   - C. Same
   - D. Same
   - E. Same
   - F. Connect the voltmeter or ammeter, whichever is applicable, to the output signal, pin #2, of the MFM
   - G.

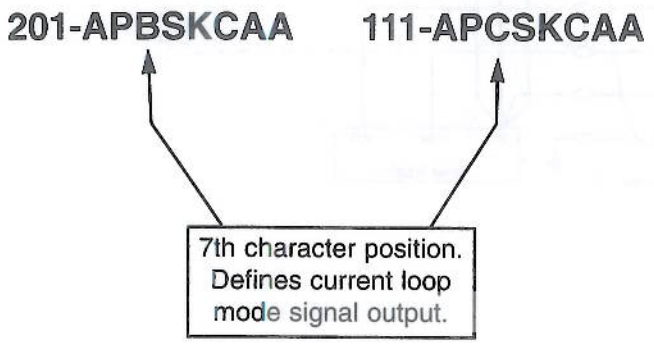
Step	Set Gas Flow (% of full scale)	Adjust Trimpot	0-5 Vdc (Vdc)	Flow Signal Output 4-20 mAdc (mAdc)	Flow Signal Output 0-20 mAdc (mAdc)
1	50	M	2.500	12	10
2	100	H	5.000	20	20
3	0	L	.025 (±0.005)	4.08 (±0.016)	0.10 (±0.02)

APPLICATION NOTE

F.N. Cicchiello

CONSIDERATIONS FOR CURRENT LOOP IMPLEMENTATION OF FLOW INSTRUMENTS

Flowmeters and flow controllers with model numbers in the 100 and 200 series utilize circuit boards which can be configured to provide flow signal output in either voltage or current mode. Flow instruments configured for current loop output can be identified by a B or C in the model number at the 7th character position. Two examples follow:



Although either mode can be selected during manufacture, the adjustments should be made prior to final flow calibration verification and are not recommended as a field-modifiable option.

Ranges available (max. operating temperature +70°C); Current output —

0 to 20 mA and 4 to 20 mA

Note that the instrument current driver is not isolated and is electrically connected to the supply common of the flowmeter/controller. Figure 9.1 indicates valid and safe output load resistance as related to various loop supply voltage sources. Additionally, the current driver is configured as a current sink and as such must be connected as illustrated in figures 9.2A and 9.2B.

Figures 9.1, 9.2A, and 9.2B are applicable to both 0-20 mA and 4-20 mA loops. In event of a loop fault, the instrument current driver is capable of sinking greater than 50 mA and permanent device damage may occur.

Discussions until now have related only to flow signal output considerations. A note is in order for flow controllers and the setpoint input characteristics.

All of the flow controllers defined by the previously identified model numbers require voltage as a setpoint input.

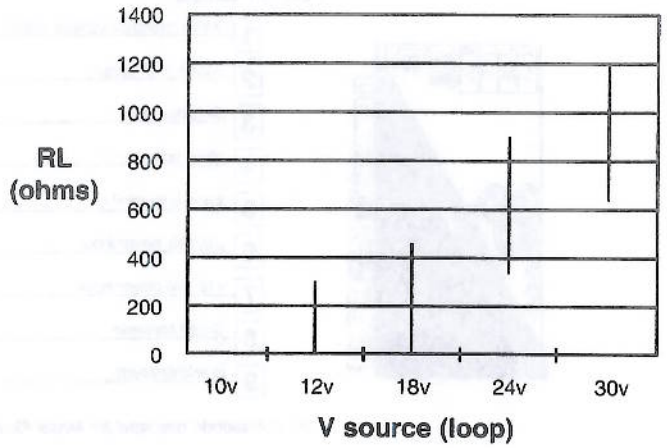


Figure 9.1. Current loop source voltage and load resistance ranges.

The voltage ranges are as follows:

FLW sig out	SETPT in
0 - 20 ma	0 V - 5 V
4 - 20 ma	1 V - 5 V

Following are 2 suggested external connecting methods for the Porter flowmeter/controller current loop.

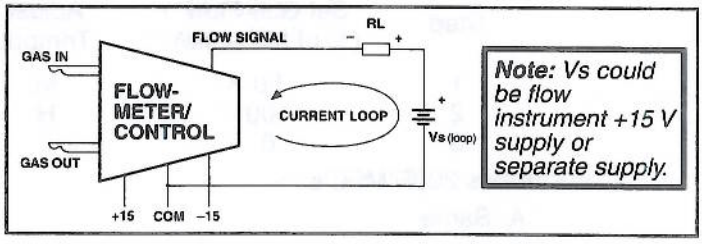


Figure 9.2A. Floating RL, Common referenced Vs.

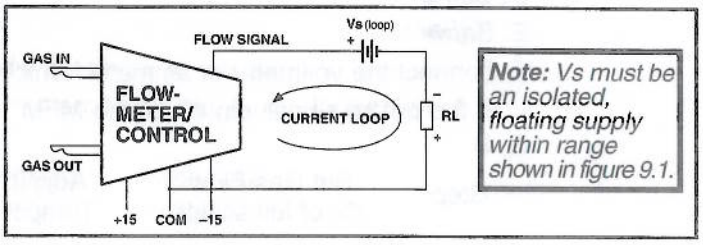
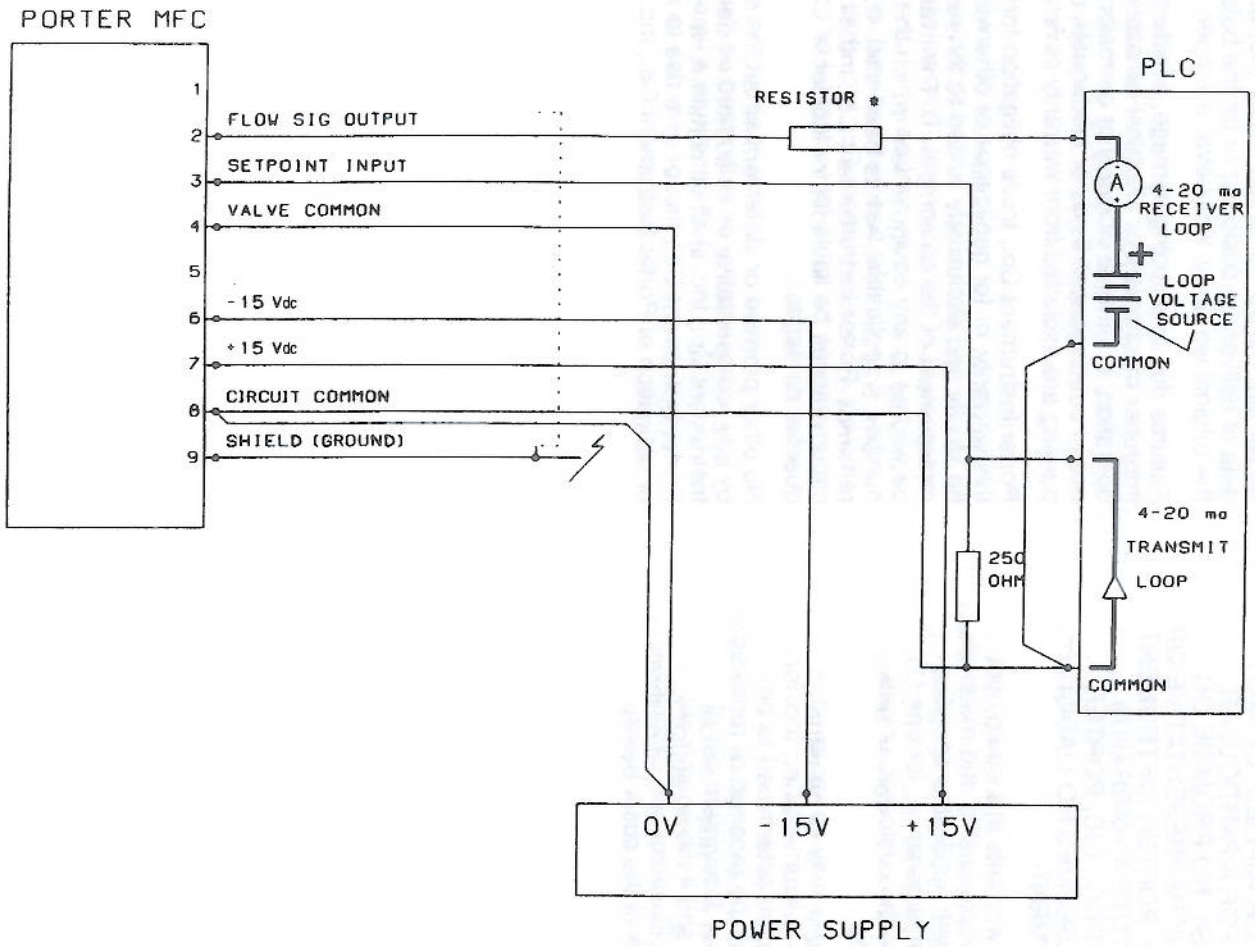


Figure 9.2B. Common referenced RL, floating Vs.



PREFERRED CONNECTION; note 2 COMMONS TO 0V AT PWR SUP

* FOR 24V LOOP VOLTAGE SOURCE, TOTAL RESISTANCE (INCLUDING INTERNAL PLC RESISTANCE) SHOULD BE BETWEEN 400-800 OHM TO PREVENT DAMAGE TO CURRENT LOOP DRIVER.

Figure 9.3

SECTION 10

CERTIFICATE OF WARRANTY

THIS WARRANTY IS GIVEN IN PLACE OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE. NO PROMISE OR STATEMENT MADE BY ANY REPRESENTATIVE OR AUTHORIZED DEALER OF PORTER INSTRUMENT CO., INC. SHALL CONSTITUTE A WARRANTY BY PORTER INSTRUMENT CO., INC. PORTER INSTRUMENT CO., INC. ASSUMES NO LIABILITY FOR USE OF THIS EQUIPMENT.

Porter Instrument Co., Inc. warrants this equipment to be free from defects in workmanship and materials, when used in accordance with applicable specifications and with appropriate maintenance, for one (1) year from date of delivery to the customer, unless otherwise specified in writing.

Equipment which malfunctions may be returned, shipment prepaid, to Porter Instrument Co., Inc. for test and evaluation. Equipment determined to be defective and in warranty will be repaired or replaced at no charge to the customer. Equipment out of warranty will be evaluated, and if the equipment does not meet original specifications and calibration, the customer will be notified of the costs before proceeding with repair or replacement. Repaired equipment will be warranted ninety (90) days from date of delivery to customer or for the balance of the original warranty, whichever is longer.

Failures due to shipping damage, accident, misuse, improper mechanical or electrical installation or operation, or internal clogging or corrosion due to use of contaminated fluids or inadequate system purging are excluded from warranty coverage.

Porter Instrument Co., Inc.'s obligation for breach of this warranty, or for negligence or otherwise, shall be strictly and exclusively limited to the repair or replacement of the equipment. This warranty shall be void as to any equipment on which the serial number, if applicable, has been altered, defaced, or removed. Porter Instrument Co., Inc. shall under no circumstances be liable for incidental or consequential damages.

No other promise or statement about the equipment by any representative or authorized dealer of Porter Instrument Co., Inc. shall constitute a warranty by Porter Instrument Co., Inc. or give rise to any liability or obligation of Porter Instrument Co., Inc.

Appendix B

Appendix B

KNF NEUBERGER, INC.
Two Black Forest Road
Trenton, New Jersey 08691-9428
Fax: 609-890-8323 · Phone: 609-890-8600

Operating and Maintenance Instructions

Diaphragm Vacuum Pump & Compressor

For Models: N05 Installation
Using Head Materials: AN, AT, AV, SN, ST, SV

OPERATING INSTRUCTIONS

Note: The following guidelines should be observed to promote safe and reliable operation of your KNF pump.

1. KNF units are all 100% oil–free. No maintenance at all is necessary for the bearings and NO lubrication should be done. All bearings are sealed and permanently lubricated. For repair service, call KNF Customer Service.
2. Be sure that the available electric power matches specifications marked on the motor. Serious damage may occur to the motor if connected to an improper voltage. All KNF units should be grounded using the provided brass screw. In the event of an electrical short circuit, grounding reduces the risk of electric shock by providing an escape wire for the electric current.
3. The pump should be placed where the surrounding temperature remains between 40°F and 104°F (5°C and 41°C). This is particularly important when the unit is installed in a confined space where heat may build up during operation.
4. Standard models are designed to *start against atmospheric pressure only, not under load (Pressure or vacuum)*. Care must be taken to eliminate load when pump is turned off for any reason. Optional modifications for the pump to start under load may be available for certain models. Contact KNF for information.
5. Use this pump only to pump air or gas, not liquids or particulates. *Damage to the pump or loss of performance can occur if liquids or particulates enter the system.* In the event that corrosive gases are to be pumped, be certain that a corrosion–resistant model is used. *The life of the pump can be prolonged if the formation of condensate within the pump is avoided.*
6. Always install the pump in such a location that it is protected from direct (or indirect) moisture contact.
7. Avoid operating the pump in very dusty conditions. If this cannot be prevented, then be sure to install an inlet filter and inspect and change it frequently.
8. If flow is throttled or restricted for any reason, care must be taken to avoid exceeding the maximum continuous operating design pressure of the unit.
9. Be sure that the pump is installed at the highest point within the system to prevent possible condensate from entering the unit.
10. Please remove any protective plastic plugs supplied in the intake or outlet ports of your pump prior to applying power to the motor.

Warning!: AC motors are thermally protected and will automatically restart unexpectedly when the overload device resets.

Don't pump flammable or explosive gases or operate this pump in an atmosphere containing flammable or explosive gases.

TROUBLESHOOTING

Your KNF Pump should perform to specifications for years if the simple operating instructions and precautions are observed.

If you experience a problem and suspect the pump, try these simple checks prior to calling for assistance:

1. Check that all system interconnections are gas-tight.
2. Remove the head assembly as described in "Changing the Diaphragm and Valves". Look for any foreign matter, usually bits of Teflon® tape or particulates carried into the valving system or crystallized material from previously pumped vapors. All of the above must be cleared out and the pump reassembled with clean parts.
3. If pitting of the pump parts or tearing of the diaphragm is observed, it is possible that the gas/vapor being pumped is capable of attacking the wetted parts of the pump. Chemical resistance charts should be consulted if you are in doubt. Generally, replacing the diaphragm and valves will restore the pump to operating specifications if the valve plate is not pitted in the valve seat area.

SPARE PARTS KITS

For Head Materials AN, SN
Kit Part Number: K005-0XNA Consists of:

Qty	ID#	Description
1	E	Valveplate Neoprene
1	H	Diaphragm Neoprene

For Head Materials AT, ST
Kit Part Number: K005-0XTA Consists of:

Qty	ID#	Description
1	E	Valveplate Teflon
1	H	Diaphragm Neoprene/Teflon

For Head Materials AV, SV
Kit Part Number: K005-0XVA Consists of:

Qty	ID#	Description
1	E	Valveplate Viton
1	H	Diaphragm Viton

Notes:
1. If your model Number begins with MPU, PU or PJ, contact KNF Customer Service for the proper Parts Kit, as the contents may differ from those kits listed above.
2. Contact KNF Customer Service for ordering information.

LIMITED WARRANTY

KNF NEUBERGER, INC. (KNF) warrants to buyer that its products will be free from defects in material and workmanship under normal and appropriate use, and agrees to repair or replace any of its products without charge for parts or labor within one year from the date of shipment to the original purchaser.

Products to be evaluated for warranty coverage:
Determination of coverage under this warranty is the sole responsibility of the manufacturing engineering representative of KNF. This determination will frequently require the return of the product to KNF. All product returns will be handled in accordance with KNF's product return policy. KNF reserves the right to inspect custom installations and devices that use KNF products as part of the warranty evaluation process. This warranty does not cover any misuse, negligence, deterioration by chemical action, unauthorized repair or alteration in any way, inappropriate handling or storage that in our judgement caused the product failure. KNF shall not be liable for any inconvenience, loss of use, or any consequential loss, damage or injury arising from any cause whatsoever. No employee, agent or representative of KNF shall have any right or authority to vary or alter the terms of this warranty. This warranty gives you specific legal rights, and you may have other rights which vary from state to state.

Important Note
KNF offers engineering and technical assistance to support the application and selection of our products. We strongly suggest that you ensure that the product you have purchased from us is suitable for the use that you intend; we cannot be responsible for any problems or inconveniences that result from the incorrect application or use of our products. If you provide enough information to us, we will work with you to optimize the performance of our products in your application.
Please call our Technical Sales Department for further information.

Return Requests / Inquiries
Direct all warranty and repair requests to KNF Customer Service Department for instructions before returning any unit for repair or evaluation. We will fax you a "Return Instruction Sheet" for guidance on the proper marking, packing and documentation requirements.

Important information conforming to the "Right To Know" act, such as a Material Safety Data Sheet may be required.

Products shipped to KNF must have a Return Materials Authorization Number (RMA) file number marked on the outside of the package, otherwise they will be refused by our receiving department.

CHANGING THE DIAPHRAGM AND VALVE PLATE

During normal use, the diaphragm and valve plate are the only parts of the pump that need to be replaced. Changing them is a simple process when the following steps are taken.

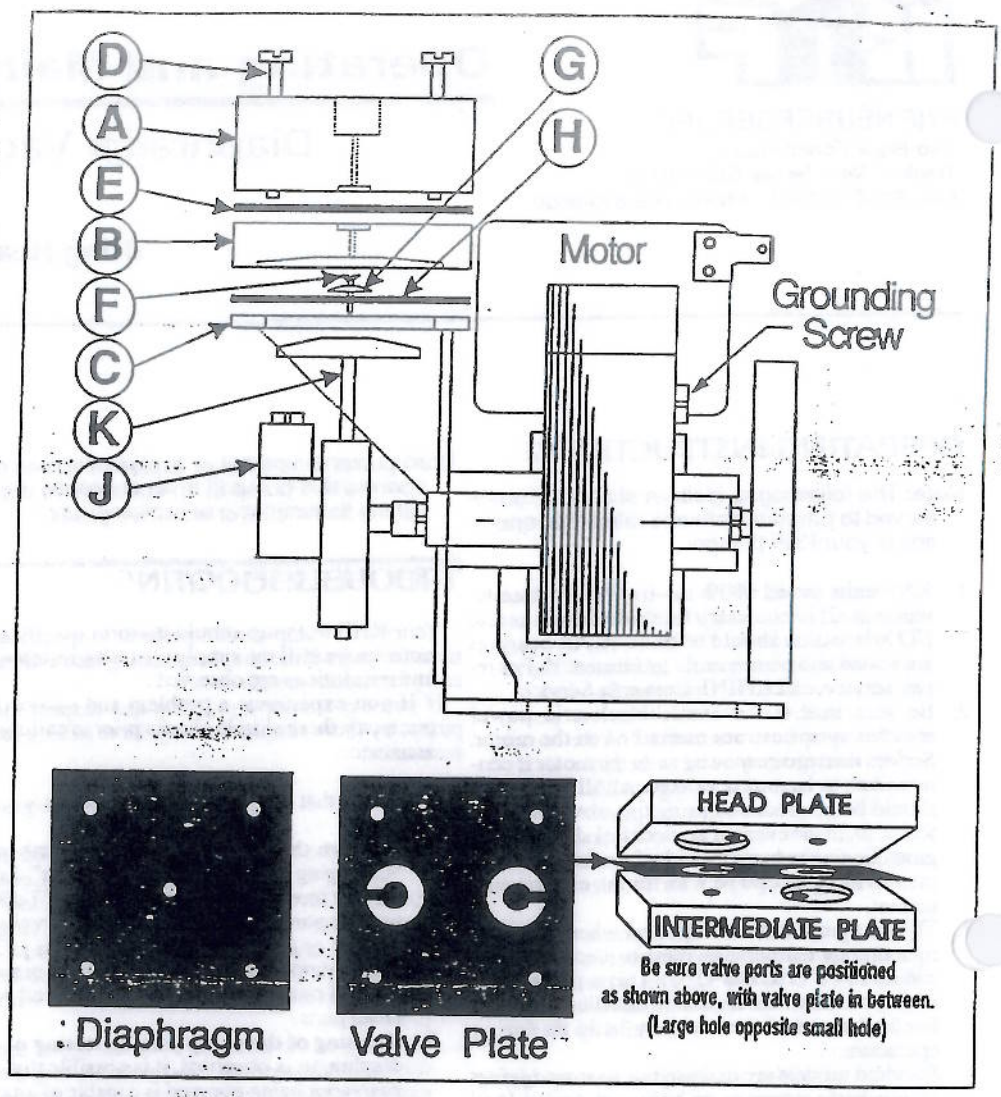
If you run into a problem or have a question regarding the following procedure, please call KNF Applications Engineering for assistance.

Materials/Tools needed:

The proper replacement kit(s)
Marking Pencil
Slotted-head screwdriver

Changing the Diaphragm

1. Disconnect the pump from electrical power.
2. Mark the relative positions of the head plate A intermediate plate B and crankcase housing C with a line using a marker for ease of reassembly later.
3. Undo the 4 slotted-head cap screws D and lift off the head plate A, valve plate E and intermediate plate B.
4. Lightly clean the valve seat area of the head plate A and intermediate plate B of any debris or deposits with fine steel wool. This area must be clean and smooth, without pits or scratches.
5. Loosen the countersunk clamping disc screw F and remove the clamping disc G, and the diaphragm H.
6. Turn the counterweight J until the connecting rod K is at mid–stroke, and place the new diaphragm H (Teflon (white) side up on AT or ST models) on the housing C, lining it up with the screw holes.
7. Place the clamping disc G (bevel side up).on top of the new diaphragm H. SNUGLY tighten the assembly using the countersunk clamping disc screw F. *DO NOT OVERTIGHTEN!*
8. Place the intermediate plate B over the diaphragm, lining up the marks made previously in step 2.
9. Place the valve plate E on top of the intermediate plate B, orienting the valve flaps with the holes. There is no top or bottom of the valve plate.
10. Place the head plate A on top of the valve plate E, lining it up with the markings you made in step 2. Note orientation of the valve ports in the diagram



11. Be sure that all components are centered, then tighten the 4 slotted-head cap screws C uniformly to a SNUG FIT in a criss-cross pattern. *DO NOT OVERTIGHTEN!*
12. Check that the pump runs freely by turning the counterweight J by hand. Check all mechanical and electrical connections for tightness.
13. Apply power to the pump. Listen for a possible "knocking sound". If it is present, equally loosen the four head screws slightly until the sound just disappears. This step is to be sure that the clamping disc does not touch the intermediate plate during operation.

Note: Excessive tightening of the clamping disc screw and the four head screws will cause premature wear on the diaphragm and bearings and must be avoided.

SPECIAL MODEL: MPU 432-N05-10.90 12VDC
CONSULT FACTORY WHEN
ORDERING SPARE PARTS
TO THIS MODEL

INNOVATIVE
TECHNOLOGY
WORLDWIDE

NEUBERGER, INC.

General Operating Recommendations
for KNF Neuberger Air, Gas & Liquid Pumps

Thank you for purchasing a quality KNF pump. Please follow these general recommendations to obtain the best performance and lifetime from your pump and to avoid any personal injury or property damage.

1. Maximum allowed ambient temperature is +40°C (+104°F). Make sure you are providing sufficient ventilation when installing pump inside a cabinet.
2. The lowest allowed operating temperature is +5°C (+40°F).
3. Connect motor to the correct voltage and frequency according to markings on the motor nameplate.
4. Don't expose the pump motor to direct contact with water or liquids, unless a water resistant option is provided.
5. Don't install the pump in an extremely dusty environment without protection.
6. When installing an air or gas pump in a system where substantial accumulation of liquid condensate could occur, mount the pump in the highest position, and if possible, upside down so that it is self-draining, so any accumulation of liquids in the pump is avoided upon system shutdown. If possible, purge accumulated moisture from the pump by running it on room air for a few minutes. Contact KNF applications department if condensation is anticipated. (Not applicable to liquid pumps)
7. Clean or replace any suction and discharge filters when they become clogged to avoid performance loss or eventual pump damage.
8. Never start the pump with *any* pressure present at the outlet or with *any* vacuum present at the inlet, unless the pump is specifically designed for this operation. Protection to prevent this should be provided for the pump if running unattended and a power failure should occur.
9. Flowrate adjustment devices should be installed on the inlet side of the pump. If a flowrate adjustment device is installed on the outlet side, make sure that the maximum allowed operating pressure is never exceeded in the volume between the pump outlet and your installed adjustment device.
10. Diaphragm pumps and compressors designed for pumping air and gases are not to be used for the pumping of liquids unless the pump is specifically modified to handle liquids. KNF liquid pumps can handle air, gases and liquids continuously without damage.
11. Don't carry a twin-head pump by its interconnection tubing. Use the handle (if supplied) or properly support the pump on the bottom of the motor and the pump housing.
12. **WARNING! - Don't pump flammable or explosive gases or operate this pump in an atmosphere containing flammable or explosive gases, unless the motor is specifically labelled as being Explosion Proof. Explosion Proof units are rated for operation with specific gases. Take precautions to operate the pump only within its rated category.**
13. Don't lubricate any of the parts of this pump or motor with oil, grease, or other petroleum products. All bearings are sealed and permanently lubricated.
14. Avoid personal injury or property damage by disconnecting power source before servicing or adjusting unit. The motor may be thermally protected and will automatically restart unexpectedly when the overload protection cools and resets.
15. The motor or connecting rod bearings should be replaced when necessary at our factory. Field replacement of bearings should not be attempted. **NEVER attempt disassembly of an Explosion Proof motor.**
16. To avoid personal injury, please remove any protective plastic plugs supplied in the intake or outlet ports of your pump prior to applying power to the motor.

This pump is one of a wide variety of vacuum pumps, compressors, liquid pumps and liquid metering pumps manufactured by KNF Neuberger. Models are available with pressure up to 170 PSIG, vacuum to ≤ 0.5 mbar (absolute), and flow from 0.10 to 300 Liters/min. We manufacture portable and installation versions, and design many with a wide variety of OEM modifications, including AC, DC and brushless DC motors to suit special needs. Contact our applications specialists for further information.

For service or parts, contact:

KNF NEUBERGER, INC.
Two Black Forest Road
Trenton, New Jersey 08691-9428

SPECIAL MODEL: MFU 463-N010-04.91 115V/60Hz
CONSULT FACTORY WHEN ORDERING SPARE PARTS FOR THIS MODEL

NEUBERGER

Diaphragm Compressors and Vacuum Pumps

Types:

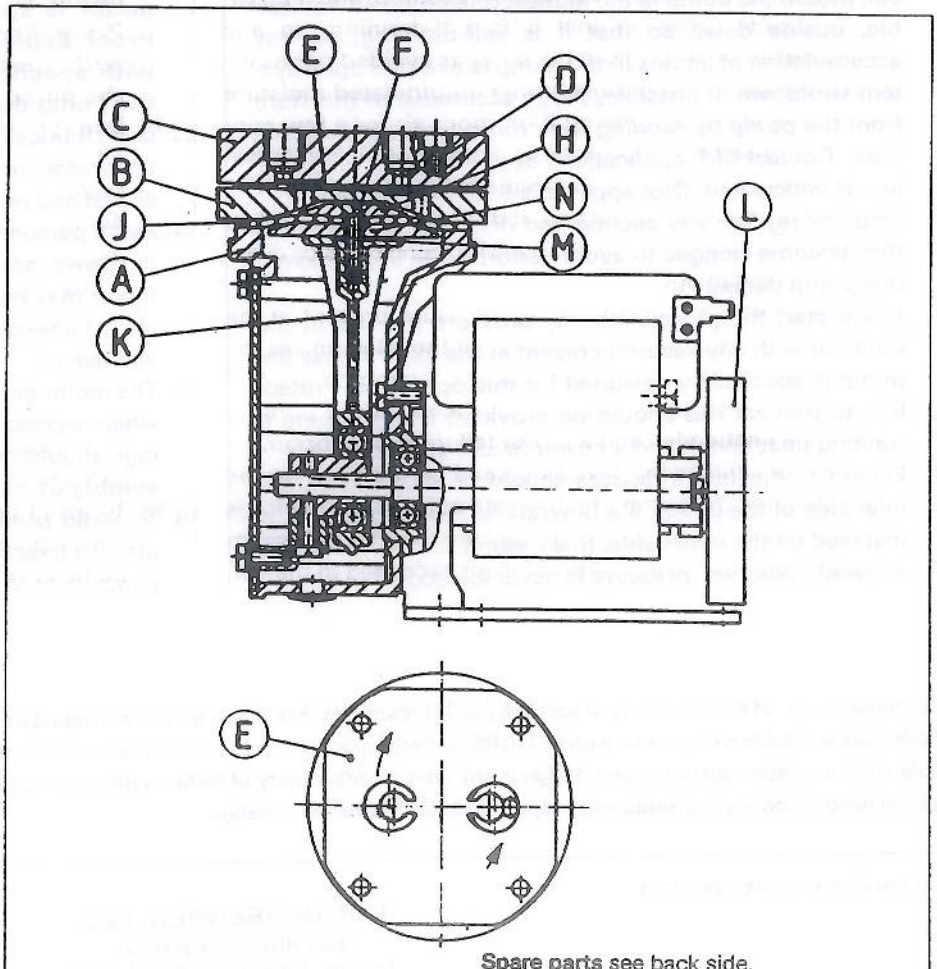
N 010 ANI	N 010 STI	N 010 ANP	N 010 STP
N 010 AVI	N 010 HNI	N 010 AVP	N 010 HNP
N 010 ATI	N 010 HVI	N 010 ATP	N 010 HVP
N 010 SNI	N 010 HTI	N 010 SNP	N 010 HTP
N 010 SVI		N 010 SVP	

Operating Instructions

KNF Neuberger compressors and vacuum pumps are designed to yield maximum, troublefree performance under all conditions. To assure safe and proper operation and to maximize the life of the unit, the following guidelines should be carefully observed:

1) Be sure that the available electric power matches specification of the electric motor.
2) Care should be taken to ensure that the temperature of the compressor or vacuum pump environment remains between 40° and 100°F. This is particularly important when the unit is installed in a confined space.
3) Unit should be started against atmospheric pressure only, not under load (pressure or vacuum). Care must be taken to eliminate load when pump is turned off for any reason.
4) Be sure that the pump is installed at the highest point within the system to prevent possible condensation from entering the unit.
5) Use only to pump air or gas, not liquids. In the event that corrosive gases are to be pumped, be certain that a corrosion-resistant model is used.
6) Always install the pump in such a location that it is protected from direct (or indirect) moisture contact.
7) Avoid operating the unit in very dusty conditions. If this cannot be prevented then be sure to install an inlet filter and inspect and change it frequently.
8) If flow is throttled for any reason, care must be taken to not exceed the maximum continuous operating design pressure of the unit.

Exchanging diaphragm and valveplate
Diaphragm and valveplate, the only parts which may wear out, are easily and quickly replaced.
a) Mark with a pencil the position between the housing A, the intermediate plate B and the headplate C.
b) Loosen the 4 hex-socket screws D and remove the headplate C, the valveplate E and intermediate plate B.
c) Loosen the countersunk screw F and remove the clamping disc H and the diaphragm J.
d) Turn the fan L until the connecting rod K is in mid-position and lay on the new diaphragm J.
e) Place the clamping disc H on top of the new diaphragm J and fasten with the countersunk screw F tightly but with feeling.
f) Place the intermediate plate B according to the pencil marking on the housing A on top of the new diaphragm J. Now place the new valveplate E (as shown on the drawing) on top of the intermediate plate B. Lastly, place the headplate C on top of the intermediate plate B. and tighten evenly with the hex-socket screws D. Check easy running by turning the fan.



Spare parts see back side.

NEUBERGER

Diaphragm Compressors and Vacuum Pumps

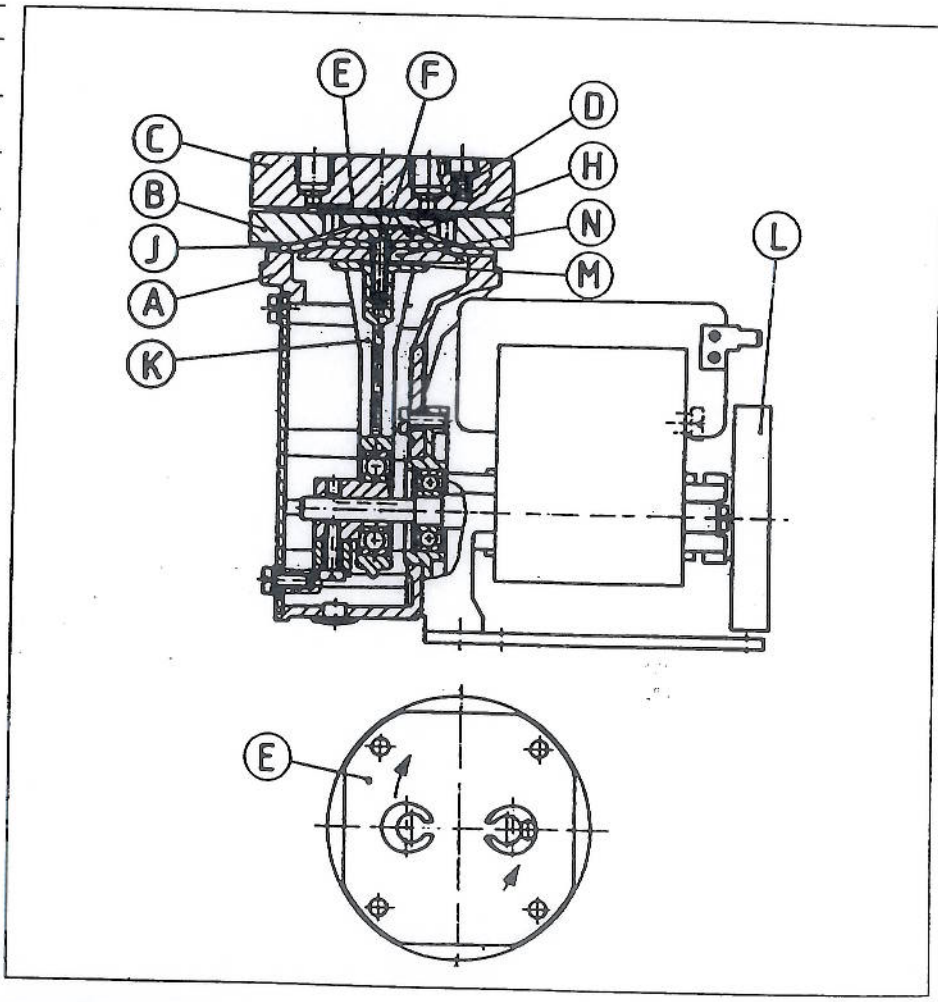
Types:

N 010 ANI	N 010 STI	N 010 ANP	N 010 STP
N 010 AVI	N 010 HNI	N 010 AVP	N 010 HNP
N 010 ATI	N 010 HVI	N 010 ATP	N 010 HVP
N 010 SNI	N 010 HTI	N 010 SNP	N 010 HTP
N 010 SVI		N 010 SVP	

Operating instructons

Spare parts

Letter	Description	Order-No.
D	socket head cap screw	14.006
E	valveplate Neoprene	N010-5.04161
E	valveplate Viton	N010-6.04621
E	valveplate Teflon	N010-6.04771
F	countersunk screw N010A...	11.059
F	countersunk screw N010S...	11.059
F	countersunk screw Hastelloy	11.060
H	clamping disk N010AN...	N010-4.09010
	N010AV...	N010-4.09010
	N010AT...	N010-4.09720
H	clamping disk N010SN...	N010-6.04820
	N010SV...	N010-6.04820
	N010ST...	N010-6.04830
H	clamping disk N010HN...	N010-6.04840
	N010HV...	N010-6.04840
	N010HT...	N010-6.04850
J	diaphragm Neoprene	N010-5.04131
J	diaphragm Viton	N010-6.04611
J	diaphragm Teflon/Neoprene	N010-6.04751
M	O-ring	21.156



Kit numbers N 010

Neoprene diaphragm, valveplate	= PK 10–001
Viton diaphragm, valveplate	= PK 10–002
Teflon diaphragm, valveplate	= PK 10–003
Teflon (heated) diaphragm, valveplate	= PK 10–004
Thermoswitch	= 10.129
Heating element	= 10.254
Connecting rod assembly	= 4–09970

KNF NEUBERGER, INC.
P.O. Box 4060 Princeton NJ 08540
Tel. (609) 799-4350, Telex 843383

Appendix C

Operating Instructions type 305

Impulse solenoid valve 3/2

This product is the result of extensive design and development work and quality-conscious manufacture. It is designed for ease of maintenance. Observance of these operating instructions will be rewarded with a long service life.

Construction:
Bistable solenoid valve, direct-acting with plunger-type armature and 2 coil windings.

Operating principle:
- A pulse applied to terminals 2 and 3 of the operating coil pulls in the armature. The valve output is opened. After the pulse, the armature remains in the operated position.
- A pulse applied to terminals 1 and 3 of the throw coil enables the armature to drop out. The valve output is closed. After the pulse, the armature remains in the non-operated position.

Fluids handled:
Neutral gases and liquids providing medium does not attack brass body or seal material. Seal material is coded after orifice size on valve label. (A = EPDM, B = NBR, F = FPM, N = CR). Pressure range as quoted on valve label.

Installation:
Before installing valve ensure all pipework etc. is free of foreign matter (metal fitings, sealing material, welding scale etc.), teflon tape is recommanded for sealing ports. Max. thread depth 8 mm. Installation as required but preferably with coil uppermost (increased valve life). Fixation is by 4 - M 4 x 8 mm tappings in underside of valve body.

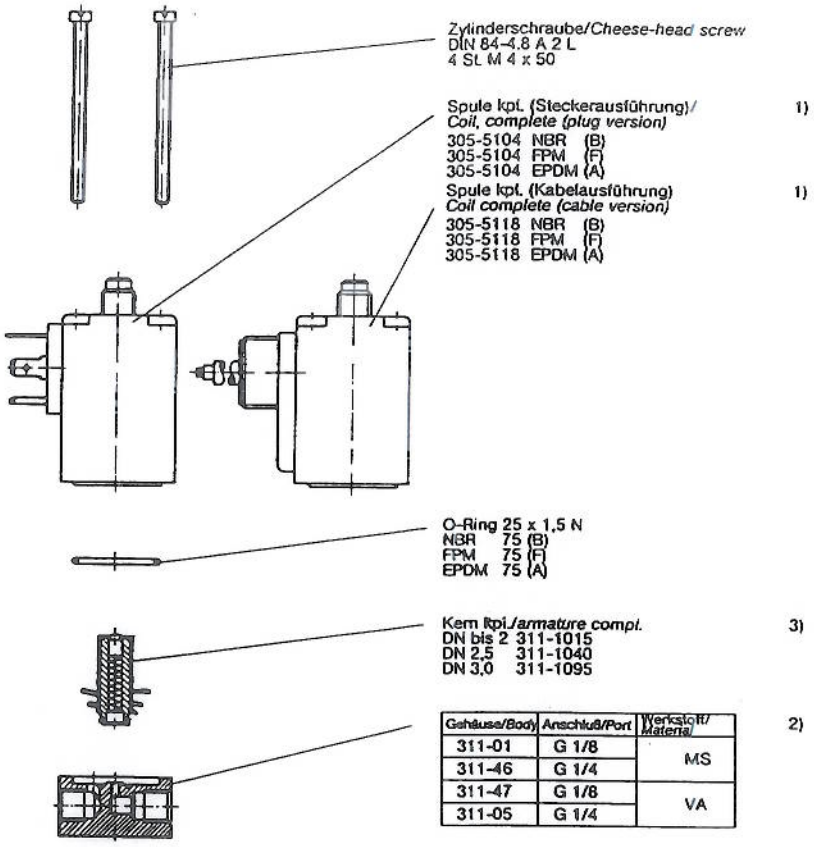
Spare parts:
Loosen four coil fixation screws and remove coil, replace any damaged parts, e.g. armature/spring assy, O-ring, coil, body. Order Nos. – see overleaf. Upon reassembly ensure O-ring correctly positioned in groove. Coil can be mounted to valve body at 90° intervals.

Electrical connections:
Ensure supply voltage/frequency corresponds with that on label. Voltage tolerance ± 10%. Electrical connection via Bürkert cable plug. Order number 1050–S 001–221, Classification IP 65. Cable plug insert can be positioned at 90° intervals. Tightening torque for cable plug screw 1 Nm. Cable 4 x 0.75 mm².

Trouble-shooting:
First check port connections, operating pressure and voltage. Other possible causes: Short-circuit, coil open circuit or foreign matter impeding armature movement.

1/12/88/M
1893092 A

bürkert



Zylinderschraube/*Cheese-head screw*
DIN 84–4.8 A 2 L
4 St. M 4 x 50

Spule kpl. (Steckerausführung)/ 1)
Coil, complete (plug version)
305-5104 NBR (B)
305-5104 FPM (F)
305-5104 EPDM (A)

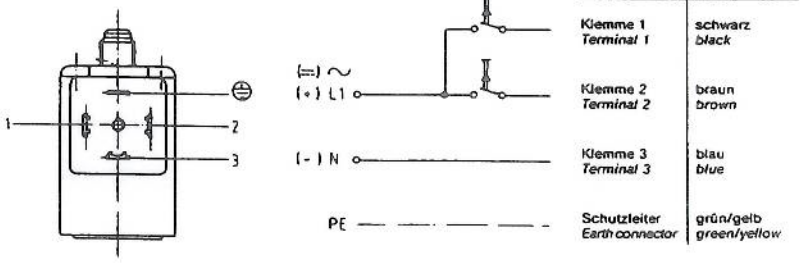
Spule kpl. (Kabelausführung) 1)
Coil complete (cable version)
305-5118 NBR (B)
305-5118 FPM (F)
305-5118 EPDM (A)

O-Ring 25 x 1,5 N
NBR 75 (B)
FPM 75 (F)
EPDM 75 (A)

Kern kpl./*armature compl.* 3)
DN bis 2 311-1015
DN 2,5 311-1040
DN 3,0 311-1095

Gehäuse/Body	Anschluß/Port	Werkstoff/ Material	2)
311-01	G 1/8	MS	
311-46	G 1/4		
311-47	G 1/8	VA	
311-05	G 1/4		

1) Spannung, Stromart, Nennweite und Dichtwerkstoff laut Typenschild und evtl. Kabellänge angeben!
2) Nennweite und Wirkungsweise laut Typenschild angeben!
3) WW, Dichtwerkstoff und Besonderheit laut Typenschild angeben!
1) Specify voltage, AC or DC, nominal diameter and sealing material as per label and state cable length where appropriate.
2) Specify nominal diameter and circuit function as per label.
3) Specify circuit function, sealing material and special features as per label.



Steckerausf. *Plug version*	Kabelausf. *Cable version*
Klemme 1 *Terminal 1*	schwarz *black*
Klemme 2 *Terminal 2*	braun *brown*
Klemme 3 *Terminal 3*	blau *blue*
Schutzleiter *Earth connector*	grün/gelb *green/yellow*

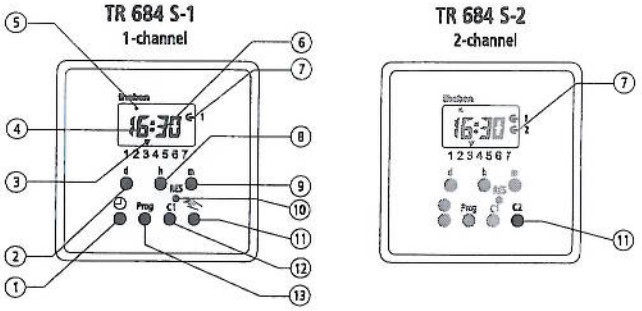
Appendix D

GB **theben**

TR 684 S-1
TR 684 S-2

Appropriate use

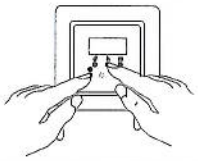
The time switch is suited for flush fitting in dry rooms. This time switch allows time dependent on and off switching of electrical appliances. This time switch can be used in enviroments with normal pollution level. At the initial start-up you can decide wheather to use the day or week program.



1 Setting real time
2 Setting day of the week
3 Cursor for indication of day of week
4 Hours display
5 Display for automatic summer ☼ / winter time switching ❄
6 Display minutes
7 Switching condition display **ON** ⋐, **OFF** ⊂
8 Hours setting
9 Minutes setting
10 RESET
11 Channel selection **C2** (only for TR 684 S-2) **ON** ⋐ / **OFF** ⊂
12 Channel selection **C1** **ON** ⋐ / **OFF** ⊂
13 Programming/ interrogation

2. Setting/ changing the current time:

1. Hold down button 🕘 .
2. Change the current time by pressing button **h** and **m**.
3. Release both buttons.



3. Programming:

TR 684 S-2 (2-channel) programmation see as following
TR 684 S-1 (1-channel) please note: start 1-channel version

A. Week programm:

Switching times can be individually set for every weekday.

Programming switch on time: (Symbol ⋐)

1. Press button **Prog** (Start 1-channel version)
2. Select **C1** or **C2** (C2 only possible with 2-channel version)
3. Press button **d** for day selection
4. Store with **Prog**.

Repeat this action if necessary e.g. same switching time on different days of the week

5. Setting the switch on-time by pressing button **h** und **m**
6. Store with **Prog**.

Programming switch off time: (Symbol ⊂)

7. Select Symbol ⊂ by pressing button C1 or C2 (C2 only 2-channel version).
8. Select Symbol ⊂ by pressing button **C1** (Start 1-channel version).
9. Repeat setting 3-6.

B. Day programm operation:

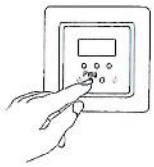
A new initial operating set-up must be carried out

Programming switch on time: (Symbol ⋐)

1. Press button **Prog** (Start 1-channel version).
2. Select Symbol ⋐ by pressing button **C1** or **C2** (**C2** only 2-channel version)
3. Setting the switch on-time by pressing button **h** und **m**
4. Store by pressing **Prog** button.

Programming switch off-time (Symbol ⊂)

5. Select **C** in step **5** to symbol ⊂ .
6. Store by pressing **Prog** button.



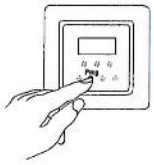
Return to automatic mode:

1. Press button 🕘 .

4. Quering programm:

1. Press button **Prog** several times.

   All stored switching times are subsequently displayed.



Return to automatic mode:

2. Press button 🕘 .

5. Changing programm:

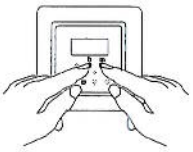
A. Weekprogramm:

Switching times can be individually set for every weekday.

Changing switch on time: (Symbol ⋐)

1. Check the switching times by pressing button **Prog.**
2. Change the switching time by pressing button **h** und **m.**

   Changing the weekdays:



Changing weekdays:

3. Press button **d** several times until only one cursor is still blinking.
4. Place cursor ▼ above desired weekday.
5. Store by pressing **Prog.** (Repeat this action if necessary).

   e.g: Lamp shall be switched on at the same time every day from mo till fri:
   Cursor ▼ must be fixed positions above 1, 2, 3, 4, 5.

6. Repeat this action if necessary.

No changing of the weekdays:

7. Store by pressing **Prog** button.

Changing of channel settings (only 2-channel version):

8. Change the channel with button **C1/ C2** and the switch **On** or **Off** you desire.
9. Store by pressing **Prog** button.

A. Dayprogramm:

1. Check the switching times by pressing button **Prog.**
2. Change the switching time by pressing button **h** und **m.**
3. Store by pressing **Prog** button.

6. Individual deletions:

1. Use **Prog** to search switching time to be deleted.
   Only the displayed switching time will be deleted.
2. Press button **h** and **m** simultaneously.

General deletion of all switching times:

3. Press button **d, h, m** simultaneously.

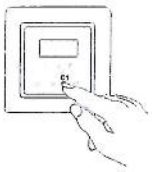
7. Switching preselection ON/ OFF:

1. Press button C1/ C2 (C2 only 2-channel version).

Result:
Alternating of channel C1/ C2 ON and OFF.

Symbol ⋐ indicates ON

Symbol ⊂ indicates OFF

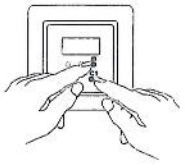


8. Permanent On/ OFF switching:

1. Hold down button m.
2. Select status using button C1/ C2.
   (C2 only 2-channel version TR 684 S-2)

   Symbol • ⋐ indicates permanent ON

   Symbol • ⊂ indicates permanent OFF

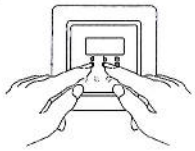


Reset permanent switching:

3. Same setting as above.
4. Press button C1/ C2 till the dot • next to the switching status disappears.
   (C2 only with 2-channel version TR 684 S-2)

9. Holiday program

The selectable holiday program allows the stored program to be interrupted.
The switching status is permanent OFF for both channels.



1. First hold down the button h through out the setting operation.
2. Use button d to set the number of days after which the holiday program is supposed to start.
3. Use button m to set the duration of the holiday program.

Interrupting the holiday program:

4. If you wish to cancel the holiday program, the display must be reset to 00 00 with the buttons h and m.

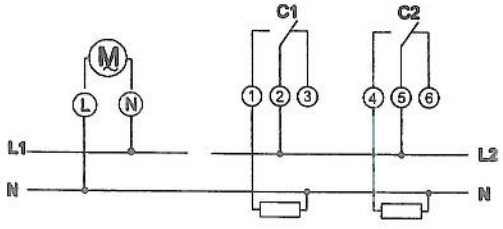
9. Security and installation:

Electrical devices should only be connected and mounted by an electrical specialist. The national specifications and applicable safety regulations must be observed.
Despite elaborate safety precautions, exceptionally strong electrical fields may cause interference with the microprocessor-controlled time switch. We therefore recommend that you observe the following points before installation:

EMC:

Time switches are in accordance with the European directives 73/ 23 EEC and 89/ 336 EEC. If the time switch is used together with other devices in an installation, take care that the complete installation does not cause a radio interference.

10. Electrical connection:



11. Initial start up

Initial start up with summer-/ wintertime adjustment

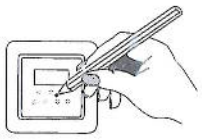
1. Press button RES.
2. Select adjustment rule f.ex. dat 1 with button C1.
3. Store by pressing Prog button.
4. Setting year by pressing button d.
5. Store by pressing Prog button.
6. Setting date of the day by pressing button d.
7. Use m to set the date of the month.
8. Store by pressing Prog button.
9. Hold down button ⏲ .

Seting are	Beginning of summer time	Beginning of winter time	Appl. bereich
dat up to 12/95	Last Sun. in March	Last Sun. in Sept.	EU
dat 1 form 1/96	Last Sun. in March	Last Sun. in Oct.	EU
dat 2	Last Sun. in March	Last Sun. in Oct.	Uk up to 1997
dat 3	1st. Sun. in April	Last Sun. in Oct.	North
no	no adjustment	no adjustment	

A. Setting week programm:

Result: Switching times can be individually set for every week.

10. Press button d.
    The current weekday is automatically set.
11. Setting the actual time by pressing button h and m.
12. Release button ⏲ .



B. Setting day programm:

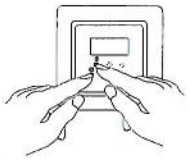
Result:
All programmable switching times will be executed at the same time every day.

1. See above without point 9

Initial start up without summer-/ wintertime adjustment

Select adjustment rule no with button C1

A. Setting week programm:



1. Press button RES.
2. Select adjustment no with button C1.
3. Store by pressing button Prog.
4. Hold down button ⏲
5. Daysetting by pressing button d (1=mo, 2=th, ..)
6. Setting the current time by pressing button h and after m.
7. Release button ⏲ .

B. Setting day program:

1. See above without point 5

Technical Data: TR 684 S-1/ TR 684 S-2

Type of program:	day or week
Operating Voltage:	230 V ± 10 %
Nominal frequency:	50 Hz
Switching capacity TR 684 S-1:	6A (1) 250 V~
Switching capacity TR 684 S-2:	2 x 6A (1) 250 V~
Time base:	Quarz
Memory locations:	36
Min. switching interval:	1 minute
Switching accuracy:	± 1 Sec. / day at 20° C
Powerreserve:	NiMH ca. 6 years at 20° C
Perm. ambient temp.:	– 10° C ... + 50° C (– 10T50)
Class of protection:	II in accordance with EN 60730-1 if installed as directed
System of protection:	IP 20 in accordance EN 60529
Type:	1 BSTU in accordance EN 60730-1 and EN 60730-2-7

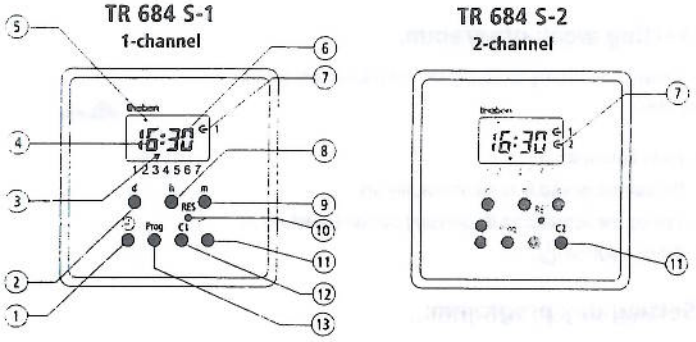
Subject to technical alterations

GB **theben** 310 599

TR 684 S-1
TR 684 S-2

Appropriate use

The time switch is suited for flush fitting in dry rooms. This time switch allows time dependent on and off switching of electrical appliances. This time switch can be used in enviroments with normal pollution level. At the initial start-up you can decide wheather to use the day or week program.



1 Setting real time
2 Setting day of the week
3 Cursor for indication of day of week
4 Hours display
5 Display for automatic summer ☼/ winter time switching ❄
6 Display minutes
7 Switching condition display **ON** ⋐, **OFF** ⊂
8 Hours setting
9 Minutes setting
10 RESET
11 Channel selection **C2** (only for TR 684 S-2) **ON** ⋐/ **OFF** ⊂
12 Channel selection **C1 ON** ⋐/ **OFF** ⋐
13 Programming/ interrogation

2. Setting/ changing the current time:

1. Hold down button 🕘.
2. Change the current time by pressing button **h** and **m**.
3. Release both buttons.

3. Programming:

TR 684 S-2 (2-channel) programmation see as following
TR 684 S-1 (1-channel) please note: start 1-channel version

A. Week programm:

Switching times can be individually set for every weekday.

Programming switch on time: (Symbol ⋐)

1. Press button **Prog** (Start 1-channel version)
2. Select **C1** or **C2** (C2 only possible with 2-channel version)
3. Press button **d** for day selection
4. Store with **Prog**.

Repeat this action if necessary e.g. same switching time on different days of the week

5. Setting the switch on-time by pressing button **h** und **m**
6. Store by pressing **Prog** button.

Programming switch off time: (Symbol ⊂)

7. Select Symbol ⊂ by pressing button C1 or C2 (C2 only 2-channel version).
8. Select Symbol ⊂ by pressing button C1(Start 1-channel version).
9. Repeat setting 3-6.

B. Day programm operation:

A new initial operating set-up must be carried out

Programming switch on time: (Symbol ⋐)

1. Press button **Prog** (Start 1-channel version).
2. Select Symbol ⋐ by pressing button **C1** or **C2** (C2 only 2-channel version)
3. Setting the switch on-time by pressing button **h** und **m**
4. Store by pressing **Prog** button.

Programming switch off-time (Symbol ⊂)

5. Select **C** in step **5** to symbol ⊂.
6. Store by pressing **Prog** button.

Return to automatic mode:

1. Press button 🕘.

4. Quering programm:

1. Press button **Prog** several times.

   All stored switching times are subsequently displayed.

Return to automatic mode:

2. Press button 🕘.

5. Changing programm:

A. Weekprogramm:

Switching times can be individually set for every weekday.

Changing switch on time: (Symbol ⋐)

1. Check the switching times by pressing button **Prog.**
2. Change the switching time by pressing button **h** und **m.**

   Changing the weekdays:

Changing weekdays:

3. Press button **d** several times until only one cursor is still blinking.
4. Place cursor ▼ above desired weekday.
5. Store by pressing **Prog.** (Repeat this action if necessary).

   e.g: Lamp shall be switched on at the same time every day from mo till fri:
   Cursor ▼ must be fixed positions above 1, 2, 3, 4, 5.

6. Repeat this action if necessary.

No changing of the weekdays:

7. Store by pressing **Prog** button.

Changing of channel settings (only 2-channel version):

8. Change the channel with button **C1/ C2** and the switch **On** or **Off** you desire.
9. Store by pressing **Prog** button.

A. Dayprogramm:

1. Check the switching times by pressing button **Prog.**
2. Change the switching time by pressing button **h** und **m.**
3. Store by pressing **Prog** button.

6. Individual deletions:

1. Use **Prog** to search switching time to be deleted.
   Only the displayed switching time will be deleted.
2. Press button **h** and **m** simultaneously.

General deletion of all switching times:

7. Switching preselection ON/ OFF:

1. Press button **C1/ C2 (C2 only 2-channel version).**

Result:
Alternating of channel C1/ C2 ON and OFF.

Symbol ⋐ indicates **ON**

Symbol ⊂ indicates **OFF**

8. Permanent On/ OFF switching:

1. Hold down button **m**.
2. Select status using button **C1/ C2**.
(C2 only 2-channel version TR 684 S-2)

Symbol ● ⋐ indicates permanent **ON**

Symbol ● ⋐ indicates permanent **OFF**

Reset permanent switching:

3. Same setting as above.
4. Press button **C1/ C2** till the dot ● next to the switching status disappears.
(C2 only with 2-channel version TR 684 S-2)

8. Holiday program:

The selectable **holiday** program allows the stored program to be interrupted.
The switching status is permanent OFF for both channels.

1. First hold down the button **h** through out the setting operation.
2. Use button **d** to set the number of days after which the holiday program is supposed to start.
3. Use button **m** to set the duration of the holiday program.

Interrupting the holiday program:

4. If you wish to cancel the holiday program, the display must be reset to 00 00 with the buttons **h** and **m**.

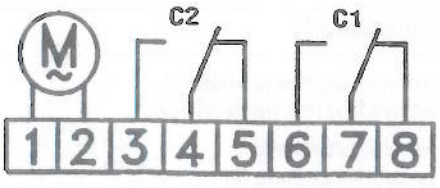
9. Security and installation:

Electrical devices should only be connected and mounted by an electrical specialist. The national specifications and applicable safety regulations must be observed.
Despite elaborate safety precautions, exceptionally strong electrical fields may cause interference with the microprocessor-controlled time switch. We therefore recommend that you observe the following points before installation:

EMC:

Time switches are in accordance with the European directives 73/ 23 EEC and 89/ 336 EEC. If the time switch is used together with other devices in an installation, take care that the complete installation does not cause a radio interference.

10. Electrical connection:



11. Initial start up

Initial start up with summer-/ wintertime adjustment

1. Press button **RES.**
2. Select adjustment rule f.ex. **dat 1** with button **C1.**
3. Store by pressing **Prog** button.
4. Setting year by pressing button **d.**
5. Store by pressing **Prog** button.
6. Setting date of the day by pressing button **d.**
7. Use **m** to set the date of the month.
8. Store by pressing **Prog** button.
9. Hold down button ◴ .

Seting are	Beginning of summer time	Beginning of winter time	Appl. bereich
dat up to 12/95	Last Sun. in March	Last Sun. in Sept.	EU
dat 1 from 1/96	Last Sun. in March	Last Sun. in Oct.	EU
dat 2	Last Sun. in March	Last Sun. in Oct.	GB
dat 3	1st. Sun. in April	Last Sun. in Oct.	North
no	no adjustment	no adjustment	

A. Setting week programm:

Result: Switching times can be individually set for every week.

10. Press button **d.**
The current weekday is automatically set.
11. Setting the actual time by pressing button **h** and **m.**
12. Release button ◴.

B. Setting day programm:

Result:
All programmable switching times will be executed at the same time every day.

1. See above without point **9**

Initial start up without summer-/ wintertime adjustment

Select adjustment rule **no** with button **C1**

A. Setting week programm:

1. Press button **RES.**
2. Select adjustment no with button **C1.**
3. Store by pressing button **Prog.**
4. Hold down button ◴
5. Daysetting by pressing button **d** (1=mo, 2=th, ..)
6. Setting the current time by pressing button **h** and after **m.**
7. Release button ◴ .

B. Setting day program:

1. See above without point **5**

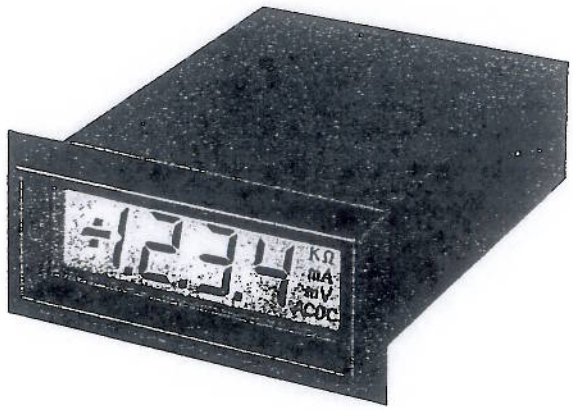
Technical Data:	TR 684 S-1/ TR 684 S-2
Type of program:	day or week
Operating Voltage:	230 V ± 10 %
Nominal frequency:	50 Hz
Switching capacity TR 684 S-1:	6A (1) 250 V~
Switching capacity TR 684 S-2:	2 x 6A (1) 250 V~
Time base:	Quarz
Memory locations:	36
Min. switching interval:	1 minute
Switching accuracy:	≤± 1 Sec. / day at 20° C
Powerreserve:	NiMH ca. 6 years at 20° C
Perm. ambient temp.:	– 10° C ... + 50° C (– 10T50)
Class of protection:	II in accordance with EN 60730-1 if installed as directed
System of protection:	IP 20 in accordance EN 60529
Type:	1 BSTU in accordance EN 60730-1 and EN 60730-2-7

Appendix E

DM-3100U1
3½-Digit, LCD DPM with Descriptors

FEATURES

- Ultra-low power, 9 mA from 9V battery
- .5" high Liquid Crystal Display
- 3½ digits, 5V or 9-15V powered, ratiometric reference for drift correction
- Programmable Descriptor Labels: A, mA, V, mV, Ω, KΩ, AC, DC
- Balanced differential inputs, 5 pA bias current, autozeroing with 80 dB CMR noise rejection
- Low profile model accepts optional 4-20 mA inputs
- Internal user-options:
  1. Offset pot for 4-20 mA and other applications
  2. Accepts shunts for ±20 μA to ±2A FS ranges
  3. Accepts attenuators for ±2V to ±1KV FS ranges
  4. Digital ohmmeter, 2KΩ to 10MΩ, FSR
- Low cost: $63.00 ea. (1 to 9)



NOTE: DPMs are normally supplied without Bezel Labels or Logos

GENERAL DESCRIPTION

The DM-3100U1 is a 3½ Digit Liquid Crystal Display (LCD) Digital Panel Meter that uses extremely low power (+5V @ 6 mA or +9V @ 3 mA) and has a power voltage range of +4V to +15 Vdc. The large 0.5" display can be seen from many feet away under normal room lighting conditions. This DPM is contained in a very small low profile case which makes for higher packing density on test panel faces. Besides measuring dc voltages, components can be placed internally to make resistance and current readings possible, and to display descriptor labels, mA, mV, KΩ, AC or DC to indicate which function is being used. Also, the decimal point can be internally selected by jumpering appropriate pins. The user may add internal attenuators to measure higher dc voltages up to ±1 kV.

The versatility of this meter is further enhanced by its autozeroing capabilities. If the customer desires, an offset pot can be internally installed so that a desired reading can be obtained with a zero input to the meter.

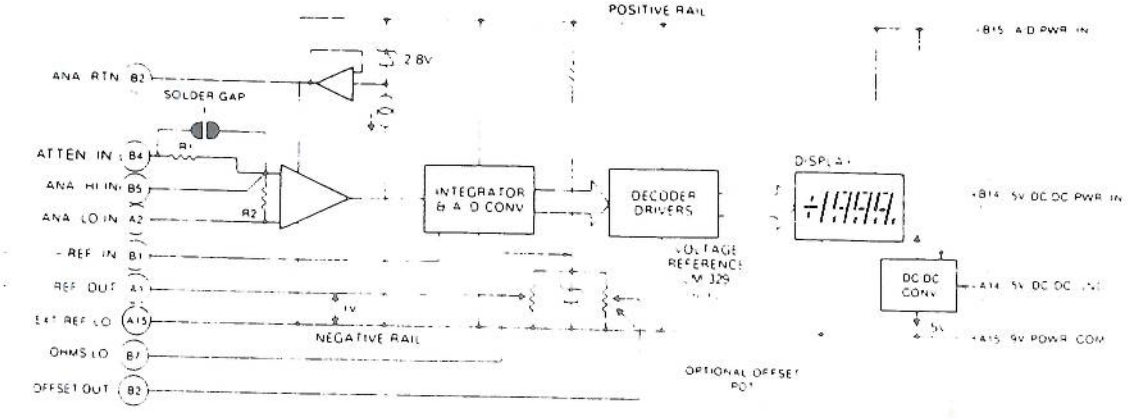
This DPM accepts a dc or slowly varying input voltage between ±1.999V and displays that input on front panel numerical indicators. It employs a conventional dual-slope A/D converter plus 7 segment display decoder-drivers all in one LSI microcircuit. Since this microcircuit requires approximately 9V to power the A/D section, an internal DC/DC converter generates −5V from +5V power input. Together these two voltage sources form a bipolar power supply to power the A/D converter. The DM-3100U1 may also be powered directly from a single 9V battery @ 3 mA without using the DC/DC converter.

Another feature of the DM-3100U1 is that it employs a balanced differential input. When used with a bridge or transducer input, it offers high noise immunity and can accurately measure very small signals in the presence of much larger common mode noise. Another characteristic of this balanced differential input is that it will not load down sensitive input circuits due to its high input impedance of 1000 megohms, and low 5 pA bias current.

A very noteworthy feature of this meter is that it can be operated ratiometrically. This means that it has internal circuits that can automatically compensate for reference drifts in the supplies of balanced bridge or transducer sensors and still give accurate readings.

The DM-3100U1 finds use in analytical instruments, industrial process controllers, portable diagnostic instruments, automatic test equipment, medical and patient monitoring instruments, airborne, marine and ground vehicles, and data acquisition/data logging systems.

SIMPLIFIED BLOCK DIAGRAM



DATEL

SPECIFICATIONS, (Typical @ +25° C unless noted)

ANALOG INPUT

Configuration
True, balanced differential bipolar
Full Scale Input Range
-1 999 Vdc to +1.999 Vdc. Input pad area will accept user-installed range change
Input Bias Current
5 pA typical, 50 pA maximum
Displayed Accuracy @+25° C
Adjustable to ±0.1% of reading, ±1 count
Resolution
1 mV
Temperature Drift of Zero
Autozeroed ±1 count over 0 to +50° C
Temperature Drift of Gain
±50 ppm of Reading/° C typ.
±100 ppm of Reading/° C max.
Input Impedance
100 Megohms, minimum
Input Overvoltage
±250 Volts dc 175 VRMS continuous max
±300 Volts intermittent max.
Common Mode Rejection
80 dB, dc to 60 Hz, 1 Kilohm unbalance
Common Mode Voltage Range
Within +Vs − .5V and −Vs +1V where +Vs is the positive rail (Pin B15) and −Vs is the negative rail (Pin A15) −Vs is approximately equal to −5V below PWR. COM.
Reference
Internal, referred to the negative rail (−Vs).
External, user-supplied reference optional for ratiometric operation
External Ref. Range
+100 mV to +2V, referred to $-V_S$
Ramp-up Time (Integration Period)
83.3 mS

DISPLAY

Number of Digits
3 decimal digits and most significant "1" digit ($3\frac{1}{2}$ digits)
Decimal Points
Selectable decimal points are included for scale multipliers.
Display Type
Field effect liquid crystal displays (LCD) requiring room light for viewing. Black digits against a light background.
Display Height
0.5 inches (12.7 mm)
Overscale
Inputs exceeding the full scale range blank the display, leaving a "1" MSD and sign
Autopolarity
A minus sign is automatically displayed for negative inputs, and may also be blanked
Sampling Rate
Factory set at 3 conversions per second. May be rewired up to 20 conversions/second
Descriptors
kΩ, mA, mV, ACDC
This field of function labels is positioned to the right of the decimal digits. Individual unit descriptors may be selected for display

I/O CONNECTIONS

Analog HI Input (Pin B5)
Analog LO Input (Pin A2)
Differential input voltages are connected between these inputs. A bias current path to POWER COMMON (if 5V-powered) or ANALOG RETURN from both these inputs must be externally provided. External circuits must constrain these inputs to be within the common mode voltage range.

Analog Return (Pin B2)
This pin may be used as a low-noise bias current return for some floating inputs. If not possible, inputs may be referenced to POWER COMMON (if 5V-powered). Analog Return is approximately −2.8V below +Vs and can sink 30 mA to +Vs. Do not connect Analog Return to +5V or +9V power. Analog Return may be connected to 5V Power Common (not 9V Pwr Com/−Vs!!) for single-ended input
Reference In/Out (Pins B1/A1)
Normally, REF. IN and REF. OUT should be jumpered together. An external floating source referred to EXT. REF. LO (Pin A15) may be substituted for ratiometric operation.
Decimal Points (Pins B8,9,10)
Connect selected pin to DECIMAL POINT COMMON (Pin B11) Connect unused decimal points or Descriptors to Backplane Out (Pin A11)
Offset Out (Pin B3)
0 to +6.9V referred to −Vs (pin A15) requires installation of optional offset pot supplied by user
Display Test (Pin B6)
Connect this input to pin B15 to test all display segments
Horizontal Polarity In (Pin A12)
Horizontal Polarity Out (Pin B12)
Normally these inputs are jumpered together to continuously display the horizontal portion of the polarity sign. Omit the jumper for applications not requiring sign display. See Backplane Out.
Vertical Polarity In (Pin A13)
Vertical Polarity Out (Pin B13)
Jumper these inputs when HORIZ. POL. is jumpered for automatic sign display with bipolar inputs. For reverse sensing applications, VERT. POL. OUT may be jumpered to HORIZ. POL. IN (no other connections). This will display a minus sign with positive inputs and no sign (implied positive) with negative inputs.
See Backplane Out.

Ohms Lo (Pin B7)
This connection is used in the ohmmeter configuration, otherwise do not use.
Backplane Out (Pin A11)
Connect all unused Polarity, Decimal Points and Descriptors to Backplane Out. For VOM or DVM applications, a 470 kΩ resistor may be used for each Decimal Point or Descriptor to A11. A rotary switch pole to B11 will then select the desired Descriptor and/or Decimal Point.
Descriptors
Electrical units are displayed by connecting to the Descriptor Common. Descriptors displayed are as follows:

"mA" (Pin A3)- "m" portion only
"kΩ" (Pin A4)- "k" portion only
"kΩ" (Pin A5)- "Ω" portion only
"mA" (Pin A6)- "A" portion only
"mV" (Pin A7)- "V" portion only
"DC" (Pin A8)
"AC" (Pin A9)
"mV" (Pin A10)-"m" portion only

IMPORTANT NOTE: The descriptors display labels only. They do not select functions. This meter does not directly measure ohms, mA, AC, etc. without first adding user-installed internal or external components.

POWER CONNECTIONS

A/D Power IN (Pin B15)
Connect this pin to +5 Vdc regulated to power the A/D converter and displays.
Connect to +9V for 9V configuration
5V DC/DC Power Common (Pin A14)
Use only for the 5V power configuration. This provides power return for the DC/DC converter.
5V DC/DC Power IN (Pin B14).
Connect to the +5V supply if a single +5V supply is to be used. This will power the DC/DC converter to generate −5V. Don't use this pin in the 9V power configuration.

POWER REQUIREMENTS

5V between B14/B15 and A14 (A15 no connection): 12 mA typ., 15mA max. *OR* 9 to 15 Vdc between B15 and A15 (B14, A14 no connection): 9V, 9 mA; 15V, 20 mA. max.
Calibration
A multiturn screwdriver pot adjusts the full scale reading (gain). Zero is automatic (autozeroing). Suggested recalibration in stable conditions is 90 days.

PHYSICAL-ENVIRONMENTAL

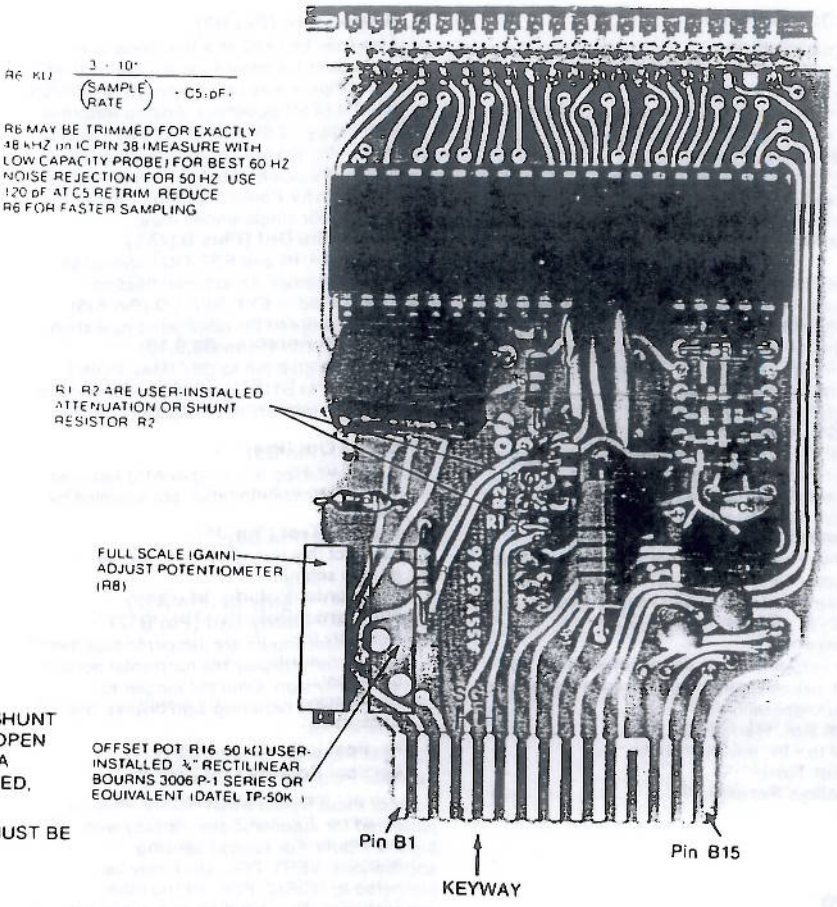
Low Profile Case Outline Dimensions
2.53"W × 3.25"D × 0.94"H (64,3 × 82,5 × 23,8 mm)
Cutout Dimensions
2.56"W × 0.97"H min. (65,1 × 24,6 mm)
Mounting Method
Through a front panel cutout secured by 2 side case "L" brackets and screws (supplied). Panel thickness up to 0.62" (15,9 mm)
Weight
Approximately 5 ounces (142g)
Connector
Double-sided edgeboard-PC type, solder tab, gold-plated fingers. 15-pin, 0.1" Datel-Intersil #58-2073083 (not included).
Mounting Position
Any
Operating Temperature Range
0 to +50°C
Storage Temperature Range *
0° C to +55° C
Altitude
0 to 15,000 feet (4900m)
Relative Humidity
20% to 80% non-condensing

**WARNING: Avoid long exposure to high temperatures.* +25° C is recommended for long-term storage.

DM-3100U1 ORDERING INFORMATION

MODEL
DM-3100U1
$3\frac{1}{2}$-digit LCD DPM.
58-2073083
Connector, dual 15-pin, 0.1" spacing; one required (not supplied with meter).
TP-50K
Optional Offset Pot, R16

DM-3100U1 COMPONENT LOCATIONS



NOTES:

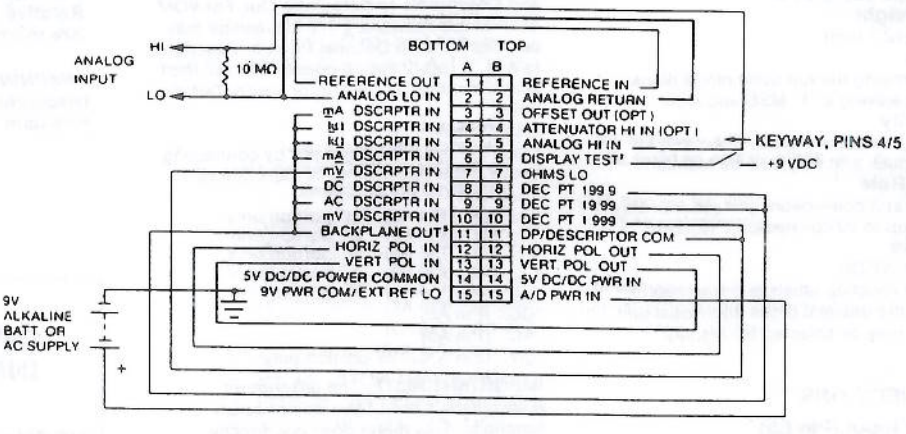
(1) R1, R2 ARE USER-INSTALLED ATTENUATION OR (R2) SHUNT RESISTORS. BEFORE INSTALLING RESISTORS AT R1, OPEN SOLDER GAP (SG1) ON COMP. SIDE OF BOARD WITH A SOLDERING IRON. NOTE THAT, IF R1 IS LATER REMOVED, THE USER MUST CLOSE THE SOLDER GAP.

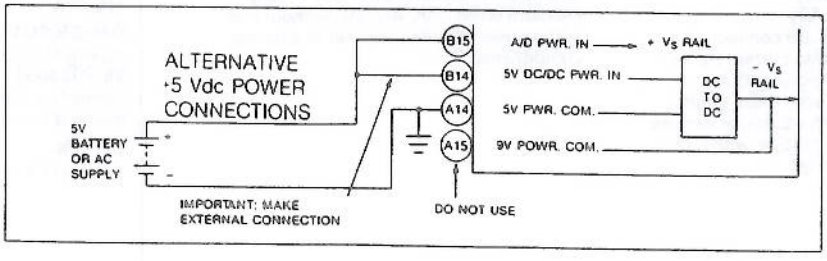
(2) ALL UNUSED DESCRIPTORS AND DECIMAL POINTS MUST BE CONNECTED TOGETHER TO A11 (BACKPLANE OUT).

INPUT/OUPUT CONNECTIONS WITH SINGLE-ENDED INPUT

CAUTION: Observe CMV range limits on single - supply applications referred to pin A15. Differential mode or batt. power is preferred. Contact Datel for assistance.

DM-3100U1

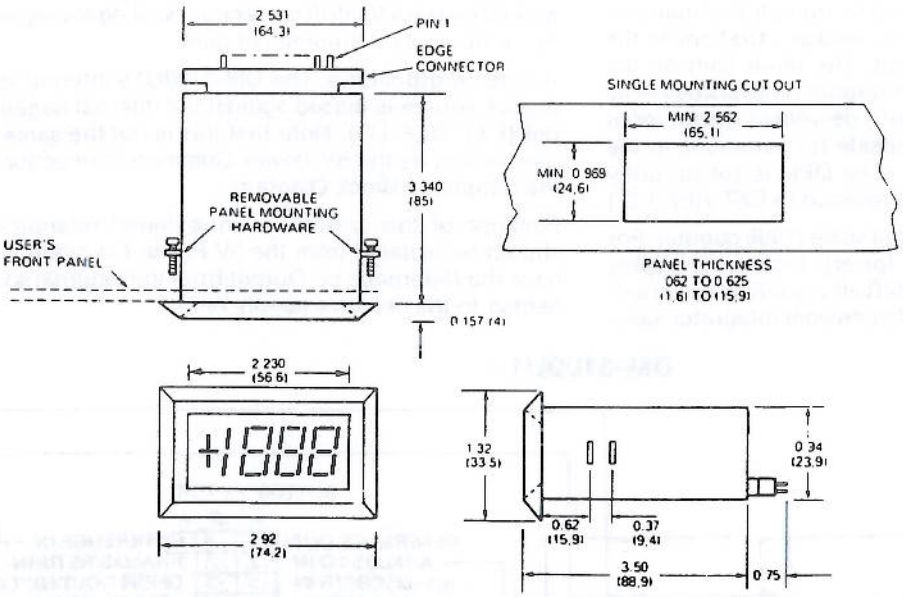




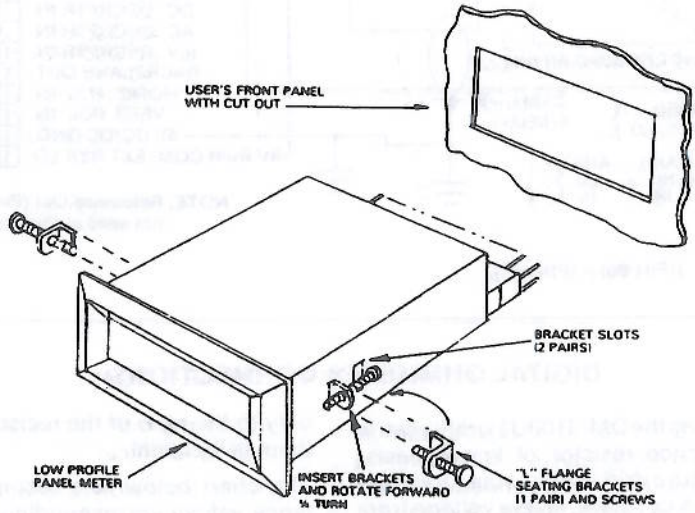
NOTES:

1. This shows the connector rear with the DPM tilted on its side.
2. CAUTION: CMOS inputs. Avoid damage from static discharge. Handle only with ground protection.
3. ANALOG RETURN = +Vs − 2.8 Vdc
4. Connect all unused Decimal Points, Descriptors and Signs to BACKPLANE OUT (PIN A11).
5. Descriptors A3 through A10 DO NOT select functions. Users must install additional components to measure Ohms, mA, etc.
6. Hold meter in DISPLAY TEST no longer than 1 minute to prevent damage to display.

MECHANICAL DIMENSIONS
INCHES (MM)



PANEL MOUNTING



The low profile case is retained in a front panel cutout by sliding the DPM housing in through the cutout opening and securing the housing from the rear using 2 "L" brackets and screws. Proceed as follows:

1. After determining the correct position, form a cutout in the mounting panel. Refer to the cutout drawing for proper dimensions.
2. Install the panel meter from the front (display) side of the mounting panel as shown.
3. There are two pairs of slots in the side of the case to receive the L-brackets and retaining screws. Most applications will use the front pair of slots. For panels thicker than about 0.25 inches (6 mm), use the rear slot pair.
4. A thin plastic molding may cover the selected slots. This can be broken through with the L brackets in the next step or can be removed using a screwdriver or knife before panel mounting.
5. Assemble the supplied 4-40 screws into the L brackets as shown, turning the screw until several threads are engaged.
6. Using the screw as a lever, push the short side of the bracket into the slot as shown and rotate the screw backwards ¼ turn until the screw is parallel to the case side and the L bracket is fully captured in the case.
7. Lightly tighten the screws against the front panel.

CIRCUIT BOARD ACCESS

If access to the internal circuit board is required, bow the rear cover plate backward by prying up in the center with a small screwdriver or knife blade, to release the two catches in the side of the case.
When reinstalling the circuit board, first be sure the front filter is flush against the inside of the housing. The circuit board engages a pair of guide tracks which are molded inside the case.
When reinstalling the rear cover plate, be sure the trim pot access hole is to the lower left when facing the rear. Compress the cover plate slightly so that it snaps into the two retaining slot catches at the rear sides.
If a second user-fabricated circuit board is installed in the upper pair of board guide tracks, the upper connector slot (if used) in the rear cover plate may be opened by using a knife from inside the cover.

DIFFERENTIAL INPUT WITH SAMPLE RATIOMETRIC CONNECTIONS.

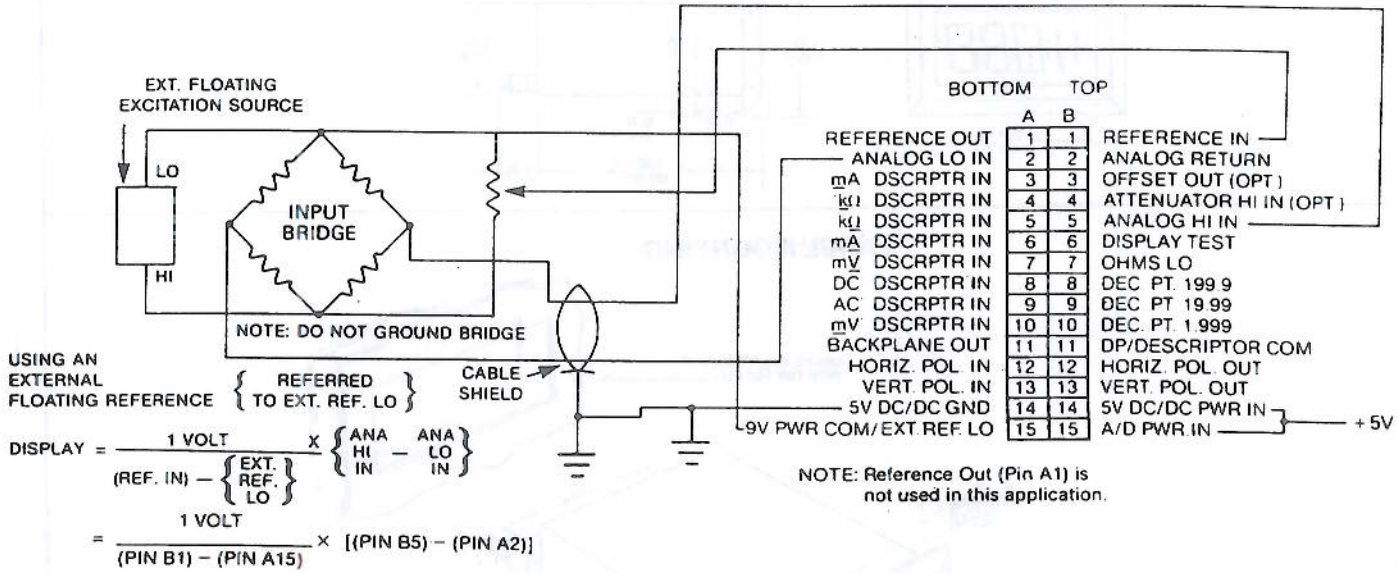
The DM-3100U1 has a reference in-out loop which makes possible ratiometric measurements. Representative connections are illustrated below. Ratiometric operation eliminates changes in the DPM reading due to voltage variations in the Bridge's external excitation source. The input gain on the DM-3100U1 varies inversely with voltage at Reference In — as REF IN voltage increases meter gain decreases. Meter input gain thus can be made to compensate for variations in the bridge excitation source voltage. (The DPM is set for unity gain when REF IN V equals +1V as referred to EXT. REF. LO.)

For all applications, $V_{IN} = 2\ V_{REF}$ at full scale (1999 counts). For small values of V_{REF} (100 mV or lower), increased display noise, nonlinearity, rollover and CMR errors will be apparent. Avoid V_{REF} inputs beyond about 2V to prevent integrator saturation with full scale inputs. Variable V_{REF} is not intended for wide gain changes as in multimeter applications. Instead, it should be used for drift correction, scaling to engineering units, or for modest amounts of gain.

A note on grounding: The DM-3100U1's internal voltage reference source is biased against the internal negative supply rail (EXT. REF. LO). Note that this is not the same electrical connection as the 5V Power Common connection. Refer to the Simplified Block Diagram.

Because of this configuration, external reference sources should be isolated from the 5V Power Common and should have the Reference Lo Output from the external source connected to the negative supply rail.

DM-3100U1

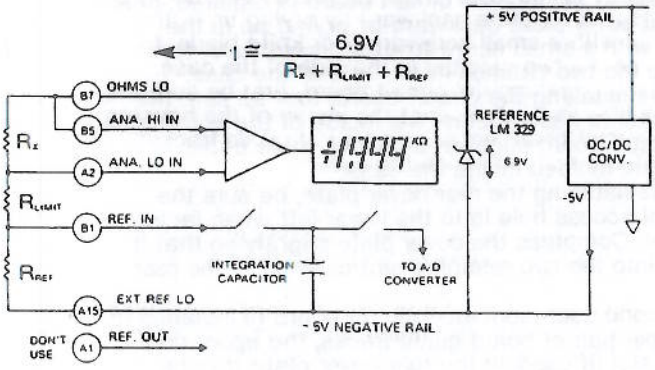


NOTE: Reference Out (Pin A1) is not used in this application.

DIGITAL OHMMETER CONNECTIONS

The digital ohmmeter circuit uses the DM-3100U1's ratiometric capability. An external reference resistor of known resistance, accuracy, and temperature drift is connected in series with the unknown resistance. A constant, stable voltage from the DPM's internal reference diode is applied to the resistor pair to produce a constant current. This current develops two voltage drops across the resistors which are proportional only to the ratio of the resistances since the current through them is identical.

The chart below lists recommended R_{REF} and R_{LIMIT} resistance values corresponding to different ohmmeter ranges. Values of R_{LIMIT} were selected to limit the current through R_{REF} and R_X to 1 milliampere maximum.

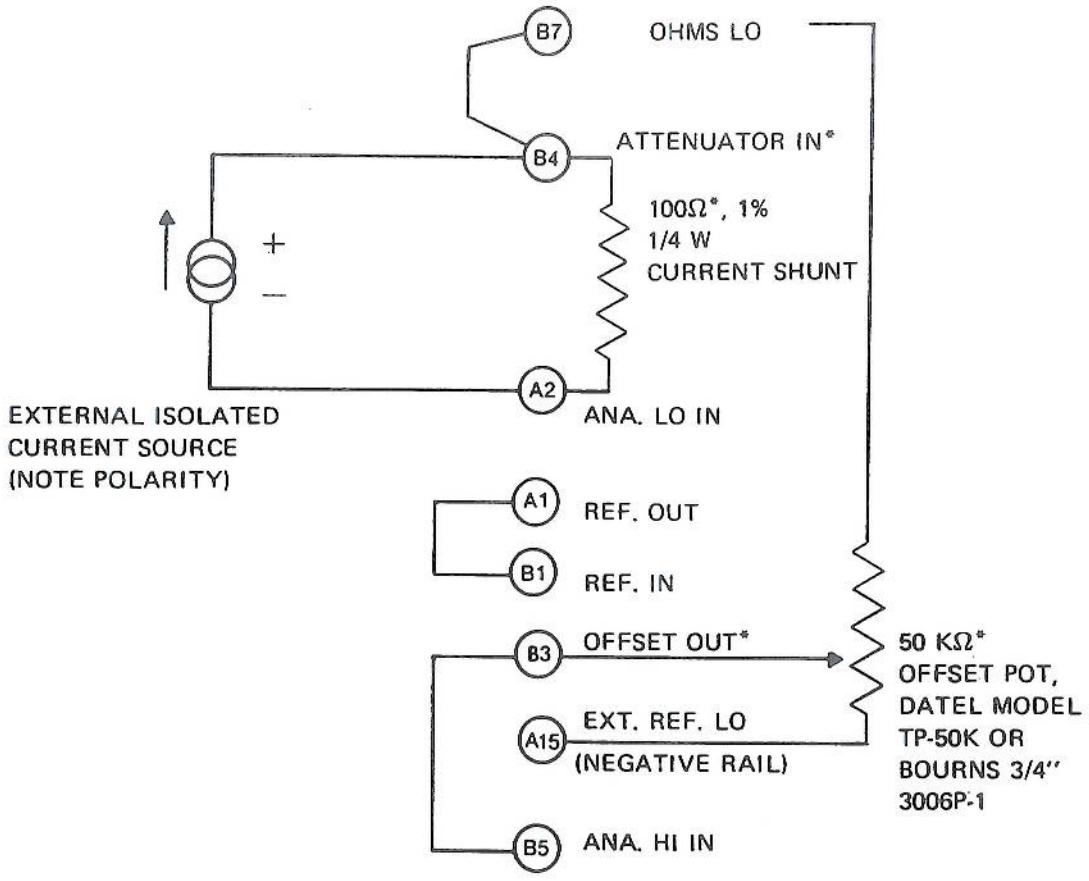


RANGE	RESOLUTION	R_{LIMIT}	R_{REF}	DECIMAL POINT[2]
19.99 MΩ	10 kΩ	22 MΩ	10MΩ	B9 to B11
1.999 MΩ	1 kΩ	3.6 MΩ	1 MΩ	B10 to B11
199.9 kΩ	100 Ω	360 kΩ	100 kΩ	B8 to B11
19.99 kΩ	10 Ω	36 kΩ	10 kΩ	B9 to B11
1.999 kΩ	1 Ω	6.2 kΩ	1 kΩ	B10 to B11

1. R_{LIMIT} and R_{REF} should be metal film, High Stability Resistors (AS RN60C).
2. All unused decimal points must be connected together to All (BACKPLANE OUT).

$$\text{DISPLAY} = \frac{E_{IN}}{V_{REF}} \times 1V = \frac{IR_x}{IR_{REF}} \times 1V = \frac{R_x}{R_{REF}} \times 1V$$

4 TO 20 MA PROCESS TRANSMITTER INPUT FOR DM-3100 SERIES DIGITAL PANEL METERS



GENERAL DESCRIPTION

This circuit accepts an isolated dc unipolar current signal from common industrial process transmitters and transducers which generate 4-20 mA dc current outputs. The circuit may also be adapted to grounded (non-isolated) current sources.

APPLICATION NOTES

This circuit may be used on Datel-Intersil's DM-3100 series Digital Panel Meters. *On the DM-3100U1, U2, U3 and DM-3100N models, the circuit is wired up exactly as shown. On these models, the 100Ω resistor may be mounted internally across both the R1 and R2 positions (leave R1 open). The 50 KΩ pot is mounted in position R16 on these model DPM's.

On Models DM-3100L, B, and X, these two components cannot be internally mounted on the board. Close the solder gap SG1 and mount the two components externally. Since there is no ATTENUATOR IN connection on the DM-3100L, and X, simply connect the 100Ω resistor and the current source **together at the OHMS LO** connection. Also, there is no OFFSET OUT connection on these models, therefore, the wiper arm of the 50 KΩ pot should be connected directly to the ANA. HI IN connection.

The current source must be isolated (floating) for this circuit to work. There must not be any ohmic path to ground from the 4-20 mA current source. If this cannot be done, float the whole DPM by using a transformer-isolated +5 Vdc power supply such as Datel-Intersil's UPA-5/500. The DM-3100B is already floating. Note the correct polarity for the current source.

CALIBRATION PROCEDURE

1. Apply 4 mA from a calibrated external current source.
2. Adjust the offset pot for the desired low reading (or zero).
3. Apply 20 mA from the current source.
4. Adjust the DPM's full scale gain pot for the desired high value.
5. Both adjustments interact slightly, therefore, repeat steps 1-4 until no further improvement can be obtained.

It is common for industrial 4-20 mA sources to represent 0 to 150 P.S.I. for example, as 4 to 20 mA. Therefore, the DPM can be adjusted to directly display engineering units.

DATEL, Inc. 11 CABOT BOULEVARD, MANSFIELD, MA 02048-1194 TEL (508) 339-3000 / TELEX 174388/ FAX (508) 339-6356
OVERSEAS: DATEL (UNITED KINGDOM) Basingstoke Tel. (256) 469-085 • DATEL (FRANCE) Tel. (1) 3460.0101
DATEL (GERMANY) Tel. (89) 53-0741 • DATEL (JAPAN) Tokyo Tel. (3) 779-1031 • Osaka Tel. (6) 354-2025

For Applications Assistance, dial 1-800-233-2765

REPRINT 1990

Appendix F

Introduction

Your Veeder-Root brand Series C342 panel instrument is powered by an internal lithium battery, features an 8 digit LCD display and is housed in a ultra compact 1/32 DIN package. An IEC IP65 rated front panel is suitable for washdown environments.

This model has been configured at the factory to perform one of the following functions: Count Totalizer, Time Totalizer (Hours:Minutes:Seconds), Time Totalizer (Hours, 1/100 resolution), or Tachometer. Easy to use programmable features that let you select a sinking or sourcing input, a count input filtering speed, and front panel reset restriction.

The following pages of the manual will provide information on proper panel mounting of the device, terminal layout and wiring instructions, directions on how to access and set the field programmable features, as well as an overview of the basic operating functions of the unit. Also included are the key product specifications, warranty procedures, and ordering information should you require additional units.

Models Covered in this Manual

C342-0464 Totalizer: Accumulates and displays counted pulses. Total can be reset via front panel button (may be disabled) or remote reset terminals.

C342-1464 Time Totalizer: Accumulates time in the format Hours:Minutes:Seconds. Can be reset via front panel button (may be disabled) or remote reset terminals.

C342-2464 Time Totalizer: Accumulates time in hours with 1/100 resolution. Can be reset via front panel button (may be disabled) or remote reset terminals.

C342-3464 Tachometer: Pulses are sampled for a 6 second period then displayed as a rate value in units per minute. A Display Hold input can freeze the current reading.

Other matching C342 models are available which offer features such as a 6 digit LED display, quadrature (bidirectional encoder) input capability, factory programmed presets and scale values, high voltage inputs, and a message display with alpha numeric capability. Ask us for more information regarding the complete C342 family of products.

Technical Manual 702083-0001

Veeder-Root brand C342 Self Powered LCD Display

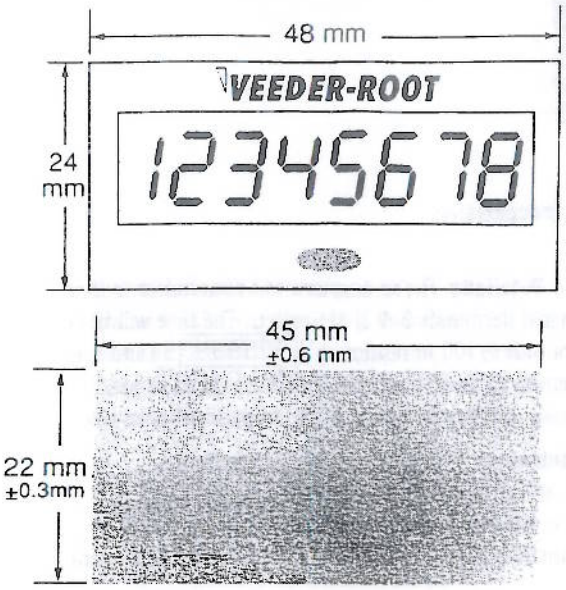
Features

- Available models include count and time totalization and rate metering
- Crisp 8 digit LCD display provides easy to read process values
- Compact 1/32 DIN bezel and 32mm behind the panel depth save panel space
- Internal lithium battery provides long life and eliminates the need for external power
- Field programmable for NPN or PNP signals and for hi-speed (7.5 kHz) or low speed (30 Hz) filtering
- IEC IP65 rated front panel for use in washdown environments

Index

INSTALLATION

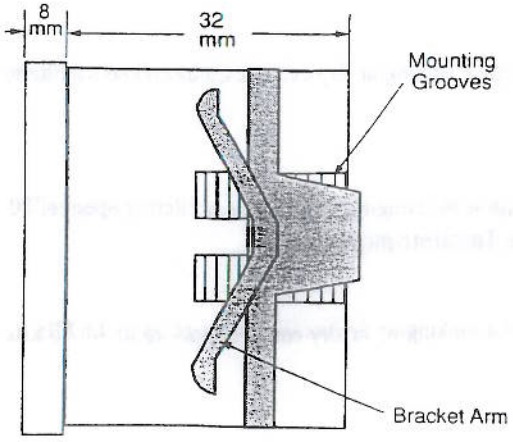
Dimensions



el Mounting

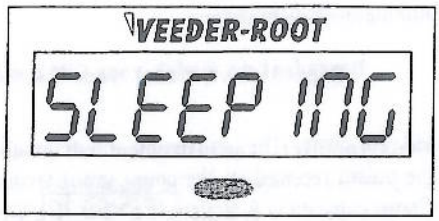
Make a panel cutout per the recommended opening illustrated by the figure above. Place the included gasket over the rear of the unit and place the unit in the panel cutout. Slide the panel mount bracket into place over the unit's rear allowing the bracket tabs to engage the grooves on the case. Continue to push forward until the bracket arm fits snugly against the panel.

Top View



Energy Conservation Mode

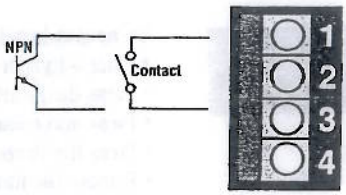
In order to maximize the lifetime of the internal battery the unit is shipped in a low energy use mode. When in this mode, the display will appear as shown in the figure below. Prior to use, the unit must be woke up by pressing the front panel reset key. Please note that the Energy Conservation Mode can not be reactivated.



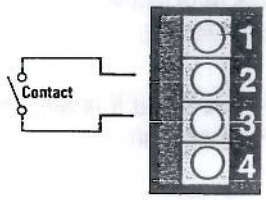
REAR TERMINAL CONNECTIONS

Wiring

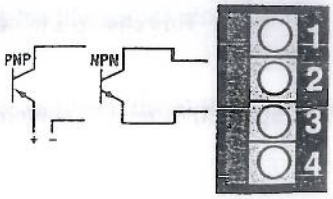
Insert wire into the appropriate openings as pictured in the drawing below. Turn the screws, located on the left side of the terminal block to tighten the clamp and secure the wire.



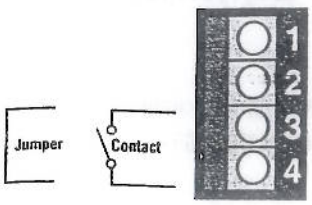
Remote Reset: the displayed value will be reset for counting or timing models. Count input is ignored when the Reset is active. ***On tachometer version***, this terminal serves as a display hold input.



Signal Input (from switch): Contact closure signals are accumulated for count and tachometer versions. ***For timer versions***, timer runs when contact is closed. See "Programming" to select Low speed, NPN mode.



Signal Input (transistor): Signal pulses are accumulated for count and tachometer versions. ***For timer versions***, timer runs when signal is present. See "Programming" for selection of PNP or NPN signal.



Reset-lock Input: When active, the Front Panel Reset Function is restricted. Use jumper for full restriction or key-switch for selective restriction.

OPERATION

Process Value Display
Displays the count, time or rate value based upon the model

Front Panel Reset
On Time or Count models, used to reset the Process Value Display. May be disabled through the keylock input. Also used to perform Programming mode functions

Dependant on model, your C342 will perform one of the following functions:

C342-0464 Totalizer: The instrument will accumulate and display the pulses received on the count input terminals (2 & 3). Count capacity is 8 digits: 12345678. The total can be reset via the remote reset terminals (1 & 3) or the front panel. Connecting terminals 3 & 4 will disable the front panel reset key.

C342-1464 Time Totalizer: The instrument will accumulate time when the input signal (terminals 2 & 3) is active. The time will be displayed in the format: 9999:59:59 Hours:Minutes:Seconds and can be reset via the remote reset terminals (1 & 3) or the front panel. Connecting terminals 3 & 4 will disable the front panel reset key.

C342-2464 Time Totalizer: The instrument will accumulate time when the input signal (terminals 2 & 3) are active. The time will be displayed in hours with 1/100 resolution 99999.99 and can be reset via the remote input terminals (1 & 3) or the front panel. Connecting terminals 3 & 4 will disable the front panel reset key.

C342-3464 Tachometer: Pulses received on the input terminals (2 & 3) are sampled for a 6 second period then displayed as a rate value in units per minute: 999990. A Display Hold function (terminals 1 & 3) will freeze the current reading.

PROGRAMMING

To access Input Configuration Parameters:
- Place a jumper between connector terminals 1 and 3
- Press the Front Panel Reset key for 8 seconds
- Press and release the Reset key to scroll display to desired configuration.
- Press the Reset key for 2 seconds to select that choice and return to Operation Mode.
- Remove the jumper from terminals 1 and 3 and continue installation.

For 8 seconds (with terminals 1 and 3 jumpered)

LO NPN

Low Speed NPN Input: Configures the unit to accept a sinking or dry contact input and sets a filtering speed of 30 Hz

LO PNP

Low Speed PNP Input: Configures the unit to accept a sourcing input and sets a filtering speed of 30 Hz
Note: This choice will not appear for Time Totalizer models

HI NPN

Hi Speed NPN Input: Configures the unit to accept a sinking or dry contact input of up to 7.5 kHz

HI PNP

HI Speed PNP Input: Configures the unit to accept a sourcing input of up to 7.5 kHz

To complete, hold for 2 seconds then remove the jumper

SPECIFICATIONS

Count Input:
Count Input: NPN or PNP Signal field selectable
Count Speed: 30 Hz or 7.5 kHz max
Logic: Low < 1.0 VDC, High > 2.0 VDC
Minimum Pulse Width: 70 µsecond
Maximum Input: 30 VDC

Operation:
Power Source: Internal Lithium Battery
Expected Battery Life: 7 years
Display Type: 8 digit LCD
Display Height: 7.6 mm
Operating Temperature: -10°C to 50°C
Storage Temperature: -20°C to 60°C
Approvals: CE Mark

Reset Input:
Type: NPN Signal, Contact Closure
Minimum Pulse Width: 15 ms

Keylock Input:
Type: NPN Signal, Contact Closure

Physical:
Dimensions: 24mm x 48mm, 32mm deep
Mounting: Panel Mount (mounting bracket supplied)
22mm (± 0.3mm) x 45mm (± 0.6mm) panel cutout
Maximum Panel Thickness: 14mm
Connections: 4 screw terminals
Weight: Approximately 2.25 ounces
Front Panel Rating: IEC IP65

ORDERING INFORMATION

Part #	Description
C342-0464	Count Totalizer
C342-1464	Timer (H:M:S)
C342-2464	Timer (Hundreths of Hours)
C342-3464	Tachometer

WARRANTY

Standard products manufactured by the Company are warranted to be free from defects in workmanship and material for a period of one year from the date of shipment, and products which are defective in workmanship or material will be repaired or replaced, at the option of the Company, at no charge to the Buyer. Final determination as to whether a product is actually defective rests with the Company. The obligation of the Company hereunder shall be limited solely to repair and replacement of products that fall within the foregoing limitations, and shall be conditioned upon receipt by the Company of written notice of any alleged defects or deficiency promptly after discovery within the warranty period, and in the case of components or units purchased by the Company, the obligation of the Company shall not exceed the settlement that the Company is able to obtain from the supplier thereof. No products shall be returned to the Company without its prior consent. Products which the Company consents to have returned shall be shipped F.O.B. the Company's factory. The Company cannot assume responsibility or accept invoices for unauthorized repairs to its components, even though defective. The life of the products of the Company depends, to a large extent, upon the type of usage thereof, and THE COMPANY MAKES NO WARRANTY AS TO FITNESS OF ITS PRODUCTS FOR SPECIFIC APPLICATIONS BY THE BUYER NOR AS TO PERIOD OF SERVICE UNLESS THE COMPANY SPECIFICALLY AGREES OTHERWISE IN WRITING AFTER THE PROPOSED USAGE HAS BEEN MADE KNOWN TO IT.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

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Revision none

Danaher Controls
1675 N. Delany Road
Gurnee, IL 60031–1282
TEL: (847) 662-2666
FAX: (847)662-6633

Appendix G

INTERNATIONAL SERIES DESCRIPTION

The INTERNATIONAL SERIES is a high reliability line of open-frame power supplies designed to operate from the wide range of AC power sources found worldwide.

This feature greatly simplifies your inventory and service considerations by allowing the use of one standard power supply regardless of destination.

Additionally, these models are designed to meet domestic and European regulatory agency requirements.

If you plan to distribute your products worldwide, obtaining necessary agency approvals can be greatly simplified by specifying POWER-ONE, INC. INTERNATIONAL SERIES.

Power-one
D.C. POWER SUPPLIES

INTERNATIONAL SERIES
DC POWER SUPPLIES

DRAWING NO. 51281 REV. L

SPECIFICATIONS AND APPLICATION DATA

VOLTAGE/CURRENT RATING CHART

MODEL	+2V	+5V	+12V	+15V	+18-20V	+24V	+28V	-5V	-12V	-15V	-18-20V	-24V	CASE
SINGLE OUTPUT													
HA5-1.5/OVP-A		1.5											B
HA15-0.9-A			0.9 or 0.9										B
HA24-0.5-A						0.5 or 0.5							B
HB2-3-A	3.0												B
HB5-3/OVP-A		3.0											B
HB12-1.7-A			1.7										B
HB15-1.5-A				1.5									B
HB24-1.2-A						1.2							B
HB28-1-A							1.0						B
HC2-6-A	6.0												C
HC5-6/OVP-A		6.0											C
HC12-3.4-A			3.4										C
HC15-3-A				3.0									C
HC24-2.4-A						2.4							C
HC28-2-A							2.0						C
HD2-12-A	12.0												D
HD5-12/OVP-A		12.0											D
HD12-6.8-A			6.8										D
HD15-6-A				6.0									D
HD24-4.8-A						4.8							D
HD28-4-A							4.0						D
HE2-18-A	18.0												E
HE5-18/OVP-A		18.0											E
HE12-10.2-A			10.2										E
HE15-9-A				9.0									E
HE24-7.2-A						7.2							E
HE28-6-A							6.0						E
HN5-9/OVP-A		9.0											N
HN12-5.1-A			5.1										N
HN15-4.5-A				4.5									N
HN24-3.6-A						3.6							N
HN28-3-A							3.0						N
DUAL OUTPUTS													
HAA5-1.5/OVP-A		1.5						1.5					AA
HAA15-0.8-A			1.0 or 0.8					▽0.4 or 1.0 or 0.8					AA
HAA24-0.6-A				0.4 or 0.6							0.4 or 0.6		AA
HAA512-A		2.0	▽0.5 or ▽0.5										AA
HAD12-0.4-A			0.4						0.4				B
HAD15-0.4-A				0.4						0.4			B
HBB5-3/OVP-A		3.0						3.0					BB
HBB15-1.5-A			1.7 or 1.5					▽0.7 or 1.7 or 1.5					BB
HBB24-1.2-A				0.9 or 1.2							0.9 or 1.2		BB
HBB512-A		3.0	▽1.25 or ▽1.25										BB
HCC5-6/OVP-A		6.0						6.0					CC
HCC15-3-A			3.4 or 3.0						3.4 or 3.0				CC
HCC24-2.4-A				1.8 or 2.4							1.8 or 2.4		CC
HCC512-A		6.0	▽2.5 or ▽2.5										CC
HDD15-5-A			5.0 or 5.0						5.0 or 5.0				E
TRIPLE OUTPUTS													
HTAA-16W-A		2.0	0.4 or 0.4					▽0.4 or ▽0.4 or ▽0.4					AA
HBAA-40W-A		3.0	1.0 or 0.8					▽0.4 or 1.0 or 0.8					BAA
HCAA-60W-A		6.0	1.0 or 1.0					▽0.4 or 1.0 or 1.0					D
HCBB-75W-A		6.0	1.7 or 1.5					▽0.7 or 1.7 or 1.5					CBB
HDBB-105W-A		12.0	1.7 or 1.5					▽0.7 or 1.7 or 1.5					DBB
CP131-A		8.0	1.7 or 1.5					▽0.7 or 1.7 or 1.5					131

HIGH VOLTAGE

MODEL	+48V	+120V	+180V	+200V	+250V	CASE
HB48-0.5-A	0.5					B
HC48-1-A	1.0					C
HD48-3-A	3.0					D
HE48-4-A	4.0					E
HB120-0.2-A		0.2				B
HB200-0.12-A ⧅			0.12 or 0.12			B
HB250-0.1-A					0.1	B

* −12V(or −15V) requires jumper on PC8 for −5V.
† for ±12V, refer to chassis silkscreen.
⧅ for 180V, refer to chassis silkscreen.
▽ 12V to 15V adjustable output
— indicates no remote sense.
Specifications subject to change without notice.

FEATURES

- VDE transformer construction
- ±.05% regulation.
- T.C. burned-in to MIL-883 Lev. B
- Chassis notched for AC input
- 100/120/220/230-240 VAC
- Industry standard size
- Full rated to 50°C
- Remote sense - most outputs
- UL recognized/CSA certified
- OVP on 5V outputs
- 2 hour burn-in period
- Foldback/current limit

SPECIFICATIONS

AC INPUT: 100/120/220/230-240 VAC* +10%, -13%, 47-63Hz (Derate output current 10% for 50 Hz operation.) See AC connection table under APPLICATION NOTES for jumper information. Fuse information is next to outline and mounting drawings.

DC OUTPUT: See Voltage/Current Rating Chart. Adjustment range ±5% minimum. (Voltage nonadjustable on HAD models.)

LINE REGULATION: ±.05% for a 10% line change. (±1% for HAD models.)

LOAD REGULATION: ±.05% for a 50% load change. (±1% for HAD models.)

OUTPUT RIPPLE: 2V to 15V outputs: 5.0mV PK-PK maximum.
24V to 250V outputs: 3.0mV+.02%Vout Pk-Pk maximum.
(HAD models: 0.1%Vout Pk-Pk maximum.)

TRANSIENT RESPONSE: ≤50us for a 50 to 100% load change.

SHORT CIRCUIT AND OVERLOAD PROTECTION: Automatic current limit/foldback.

OVERVOLTAGE PROTECTION: Built-in on all 5V outputs. Set at 6.2VDC ±0.4V. Other outputs may use optional overvoltage protection

REMOTE SENSING: Provided on most models, open sense lead protection built-in.

STABILITY: ±0.3% for 24 hour period after 1 hour warm-up.

TEMPERATURE RATING: 0°C to 50°C full-rated, derated linearly to 40% at 70°C. 12 CFM forced air cooling required to meet IEC 380/950 above 80% of total rated output power.

TEMPERATURE COEFFICIENT: ±.03%/°C maximum.

EFFICIENCY: (typical) 2V to 5V outputs: 45%
12V and 15V outputs: 55%
24V through 28V & 48V through 250V outputs: 60%

VIBRATION: Per MIL-STD-8100,Method 514.3,Category 1,Procedure I.

SHOCK: Per MIL-STD-8100,Method 516.3,Procedure III.

* Tolerance for 230VAC operation is +15%, -10%.
Note: specifications subject to change without notice.

WARRANTY

POWER-ONE, INC. warrants each power supply of its manufacture that does not perform to published specifications, as a result of defective materials or workmanship, for a period of two (2) full years from the date of original delivery.

POWER-ONE, INC. assumes no liabilities for the consequential damages of any kind through the use or misuse of its products by the purchaser or others. No other obligations or liabilities are expressed or implied.

PRODUCTS RETURNED FOR REPAIR

Please follow this procedure when returning products for servicing:

1. Contact Power-One's Customer Service Department for authorization to return products:

   POWER-ONE, INC.
   740 Calle Plano
   Camarillo, CA 93012
   USA

   PHONE: (805) 987-8741
   (800) 678-9445
   FAX: (805) 388-0476
   TWX: 910-336-1297

2. A Returned Material Authorization (RMA) will be issued and must appear on all shipping documents and containers.

3. Products must be returned freight pre-paid. Products returned freight collect or without an RMA number will be rejected and returned freight collect.

APPLICATION NOTES:

REMOTE SENSE

Remote sense terminals may be used to compensate for output line losses and provide for a remote point of regulation. Figure 1 shows the proper termination for a power supply with remote sensing.

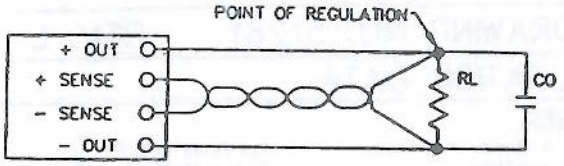


FIGURE 1

Load lines must be sized to prevent an excessive voltage drop from the output to the load. Since the point of regulation is at the load, the power supply must compensate for line losses. Excessive load line losses may affect current limiting, AC line dropout point and OVP margin (if applicable).

Leads should be sized to drop no more than 0.5V – the less the better. Use of a twisted pair or shielded pair for the sense lines is recommended for noise immunity. In problem applications, the use of a small AC decoupling capacitor (.1 to 10uF) across the sense terminals is highly recommended. In some applications there may be a tendency for the power supply to oscillate due to additional phase shift caused by the series resistance and inductance in the load leads. The addition of capacitor Co will reduce output impedance and provide stability. The recommended value of Co is 100uF per ampere of 50uF per foot and can be the sum of the distributed decoupling capacitors found in most systems.

All Power-One supplies have open sense lead protection to protect the load from an overvoltage condition if the sense leads are removed. There is no need to strap the sense terminals to the output terminals in the local sense mode.

OVERVOLTAGE PROTECTION (OVP)

An overvoltage protection circuit, commonly refered to as a crowbar, is used to prevent damage to voltage sensitive loads such as TTL logic. Trip point of the OVP is usually set at 115% – 135% of the output voltage. The OVP will short the output terminals upon sensing a fault condition. The primary fuse of the supply will blow if the supply is not foldback current limited. Nuisance tripping of the OVP is a common problem. Noise from input line spikes or load noise can cause an OVP to fire. The INTERNATIONAL SERIES has OVP noise filtering to prevent nuisance tripping and reduce transformer interwinding capacitance to minimize input line susceptibility.

COMMON-MODE LATCH UP

In certain instances dual power supplies can exhibit a problem known as common-mode latch up. This occurs when the positive supply comes up first and forces a reverse bias condition on the negative supply. The negative supply latches up in a current limit condition. Power-One has incorporated a unique anti-latch circuit into every dual power supply in the INTERNATIONAL SERIES which will minimize this problem.

EMI/RFI

These linear power supplies have inherently low conducted and radiated noise levels. For most system applications they will meet the requirements of FCC Docket 20780 for Class A equipment and VDE 0871 for Class A equipment without additional noise filtering.
For special applications consult factory.

COOLING

Convection cooling is adequate where non-restricted air flow is available. When operating in a confined area, moving air or conduction cooling is recommended.

SAFETY SPECIFICATIONS

The INTERNATIONAL SERIES power supplies were designed to meet or exceed requirements for the following specifications: IEC 380, IEC 435, VDE 0730 Part 2, VDE 0804, ECMA-57, CEE 10 Part 2P, UL 1012, CSA 22.2 No. 143, CSA 22.2 No. 154. Specifically field terminal to terminal spacing is 5.25 mm with 9.0 mm creepage to other metal, leakage current is less than 5.0uA and dielectric withstanding voltages are 3750 VAC input to chassis, 3750 VAC input to output and 300 VDC output to chassis.

GROUNDING

Grounding considerations in designing a power distribution system are often overlooked but can have a significant impact on overall system performance. A single point system ground should be employed where possible to eliminate ground loops and improve regulation.

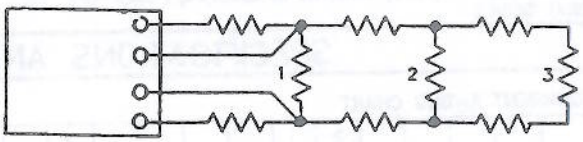


FIGURE 2

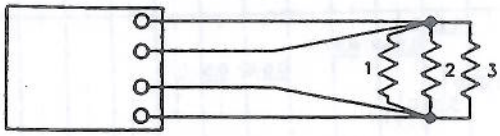


FIGURE 3

Figure 2 shows a simple but undesirable connection scheme. Regulation at loads 2 and 3 becomes progressively worse due to voltage drops in the finite wire resistance between loads. Figure 3 shows an improved connection system in which regulation is maintained at all three loads because wire losses are not cumulative.

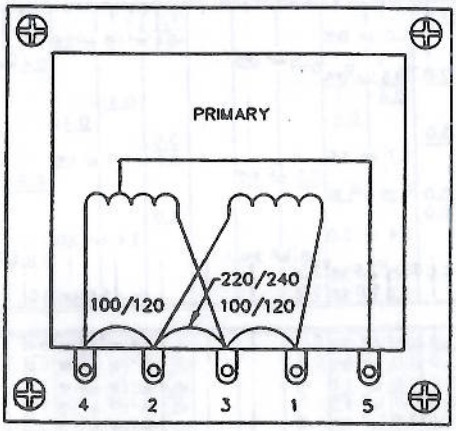
AC INPUT CONSIDERATIONS

Almost all power supplies use a capacitive input filter that draws current only at the peaks of the AC input voltage. The peak to RMS ratio can be very high, typically 3 to 1. When a supply is turned on, the input capacitor has a very low impedance and draws an initially high surge current until it charges to its nominal voltage. The input surge current can be as high as 20 times the rated input current and lasts for several cycles of the AC input.

AC CONNECTION AND FUSING*

The five wire input to the INTERNATIONAL SERIES provides four voltage ranges: 100/120/220/230-240** +10%, -13%. See chassis AC connection table (Figure 4) for the jumpering requirements. For convenience the jumper sequence from the Hi-Vol series is retained. Extended low line tolerance provides additional drop out margin in areas where line voltages are marginal. Inputs must be fused.

FIGURE 4

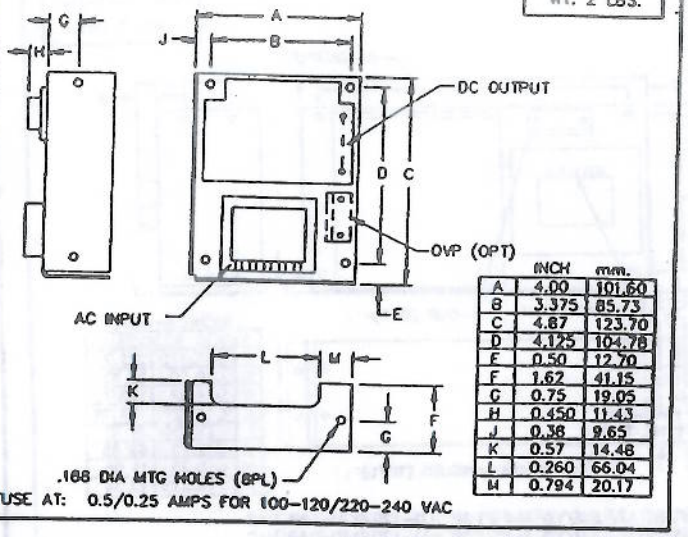


AC INPUT, 47-63 HZ				
FOR USE AT	100 VAC	120 VAC	220 VAC	230/240 VAC
JUMPER	1&3 2&4	1&3 2&4	2&3	2&3
APPLY AC	1&5	4&1	1&5	4&1

NOTE: This product is a Class 1 power supply and requires the chassis to be connected to earth ground at end application.
*NOTE: Use 700°C iron for soldering input connections. Varnish acts as flux and is solder strippable.
**NOTE: Tolerance for 230VAC operation is +15%, -10%.

OUTLINE AND MOUNTING DRAWINGS

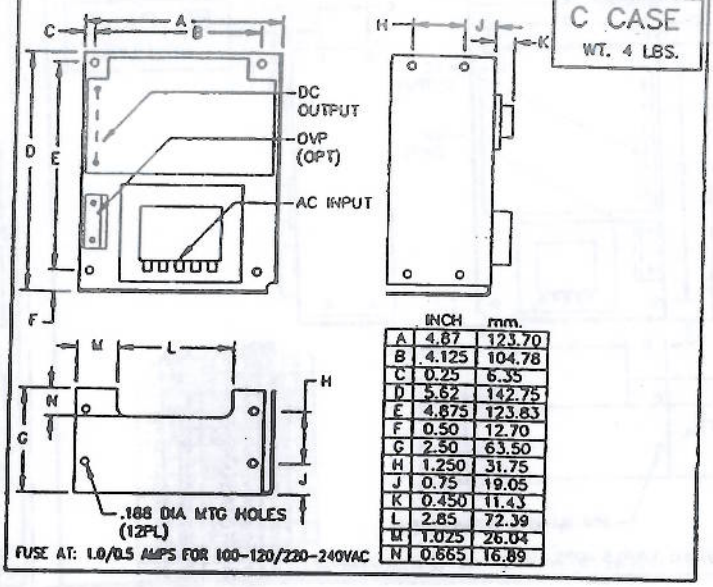
B CASE
WT. 2 LBS.



	INCH	mm.
A	4.00	101.60
B	3.375	85.73
C	4.87	123.70
D	4.125	104.78
E	0.50	12.70
F	1.62	41.15
G	0.75	19.05
H	0.450	11.43
J	0.38	9.65
K	0.57	14.48
L	0.260	66.04
M	0.794	20.17

FUSE AT: 0.5/0.25 AMPS FOR 100–120/220–240 VAC

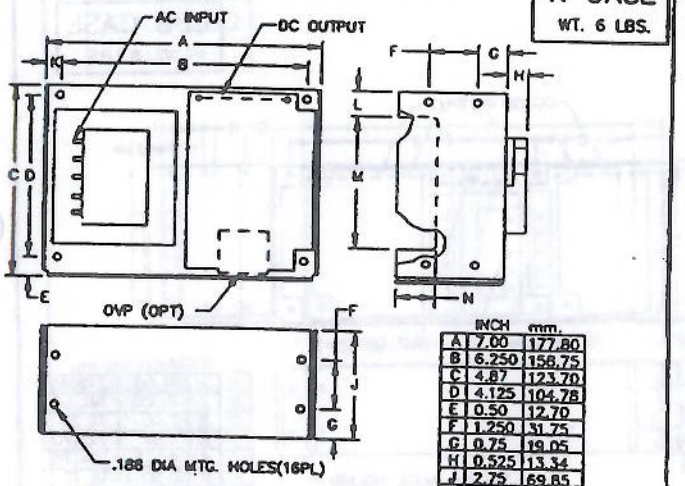
C CASE
WT. 4 LBS.



	INCH	mm.
A	4.87	123.70
B	4.125	104.78
C	0.25	6.35
D	5.62	142.75
E	4.875	123.83
F	0.50	12.70
G	2.50	63.50
H	1.250	31.75
J	0.75	19.05
K	0.450	11.43
L	2.85	72.39
M	1.025	26.04
N	0.665	16.89

FUSE AT: 1.0/0.5 AMPS FOR 100–120/220–240VAC

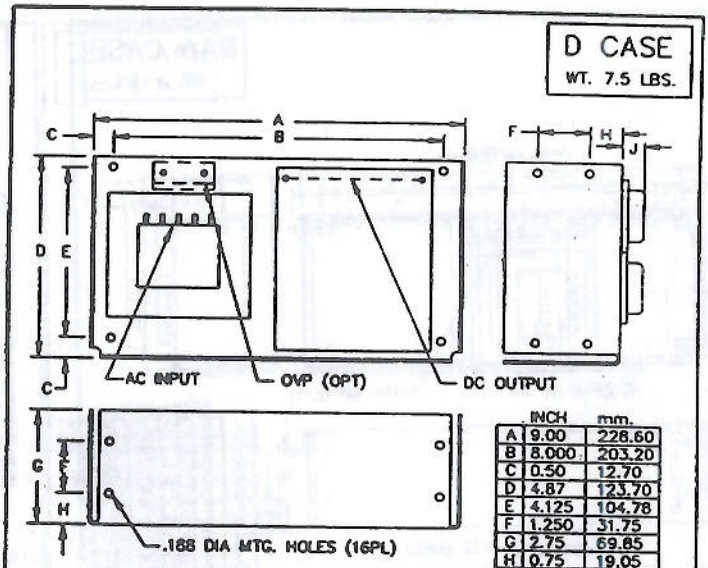
N CASE
WT. 6 LBS.



	INCH	mm.
A	7.00	177.80
B	6.250	158.75
C	4.87	123.70
D	4.125	104.78
E	0.50	12.70
F	1.250	31.75
G	0.75	19.05
H	0.525	13.34
J	2.75	69.85
K	0.38	9.65
L	0.640	16.26
M	3.35	85.09
N	1.00	25.40

FUSE AT: 2.0/1.0 AMPS FOR 100–120/220–240 VAC

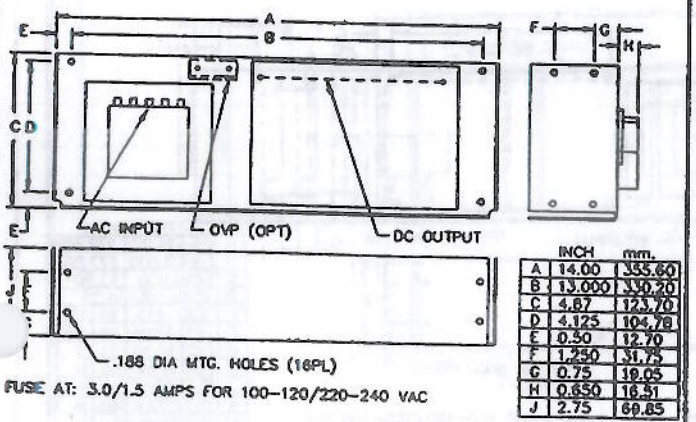
D CASE
WT. 7.5 LBS.



	INCH	mm.
A	9.00	228.60
B	8.000	203.20
C	0.50	12.70
D	4.87	123.70
E	4.125	104.78
F	1.250	31.75
G	2.75	69.85
H	0.75	19.05
J	0.525	13.34

FUSE AT: 2.0/1.0 AMPS FOR 100–120/220–240 VAC

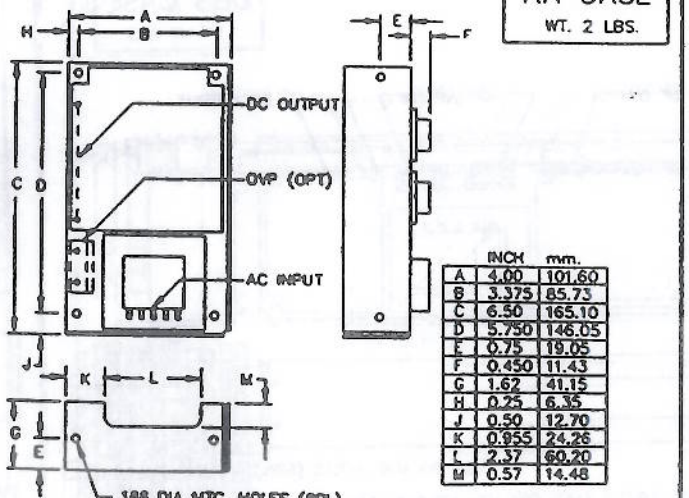
E CASE
WT. 10 LBS.



	INCH	mm.
A	14.00	355.60
B	13.000	330.20
C	4.87	123.70
D	4.125	104.78
E	0.50	12.70
F	1.250	31.75
G	0.75	19.05
H	0.650	16.51
J	2.75	69.85

FUSE AT: 3.0/1.5 AMPS FOR 100–120/220–240 VAC

AA CASE
WT. 2 LBS.

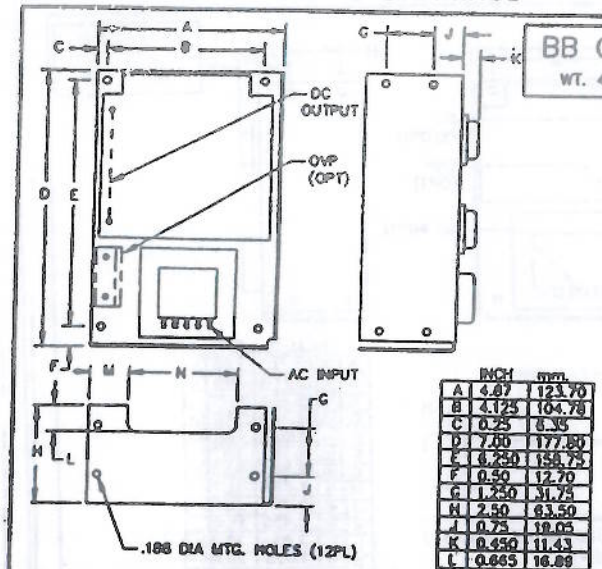


	INCH	mm.
A	4.00	101.60
B	3.375	85.73
C	6.50	165.10
D	5.750	146.05
E	0.75	19.05
F	0.450	11.43
G	1.62	41.15
H	0.25	6.35
J	0.50	12.70
K	0.955	24.26
L	2.37	60.20
M	0.57	14.48

FUSE AT: 0.5/0.25 AMPS FOR 100–120/220–240 VAC
NTAA: 0.75/0.375 AMPS FOR 100–120/220–240 VAC

OUTLINE AND MOUNTING DRAWINGS

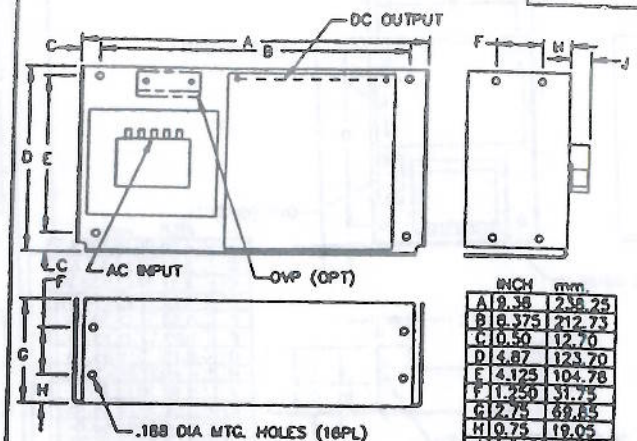
BB CASE
WT. 4 LBS.



	INCH	mm.
A	4.87	123.70
B	4.125	104.78
C	0.25	6.35
D	7.00	177.80
E	6.250	158.75
F	0.50	12.70
G	1.250	31.75
H	2.50	63.50
J	0.75	19.05
K	0.450	11.43
L	0.665	16.89
M	1.025	26.04
N	2.85	72.39

FUSE AT: 1.0/0.5 AMPS FOR 100-120/220-240VAC

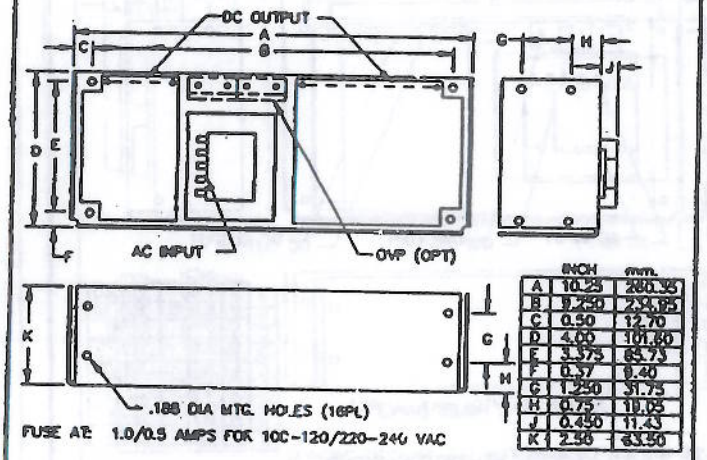
CC CASE
WT. 7 LBS.



	INCH	mm.
A	9.36	238.25
B	8.375	212.73
C	0.50	12.70
D	4.87	123.70
E	4.125	104.78
F	1.250	31.75
G	2.75	69.85
H	0.75	19.05
J	0.525	13.34

FUSE AT: 2.0/1.0 AMPS FOR 100-120/220-240 VAC
HCC512: 3.0/1.5 AMPS FOR 100-120/220-240 VAC

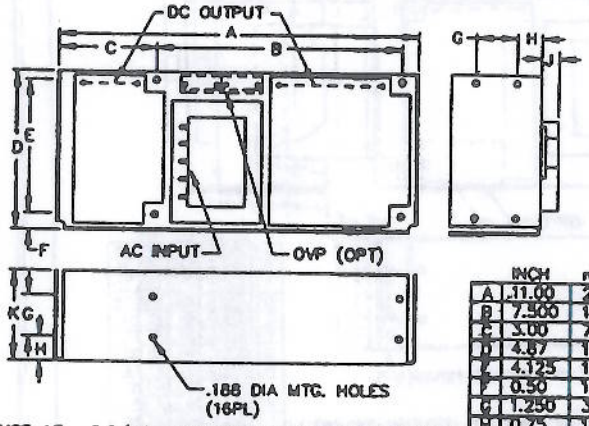
BAA CASE
WT. 5 LBS.



	INCH	mm.
A	10.25	260.35
B	9.250	234.95
C	0.50	12.70
D	4.00	101.60
E	3.375	85.73
F	0.37	9.40
G	1.250	31.75
H	0.75	19.05
J	0.450	11.43
K	2.50	63.50

FUSE AT: 1.0/0.5 AMPS FOR 100-120/220-240 VAC

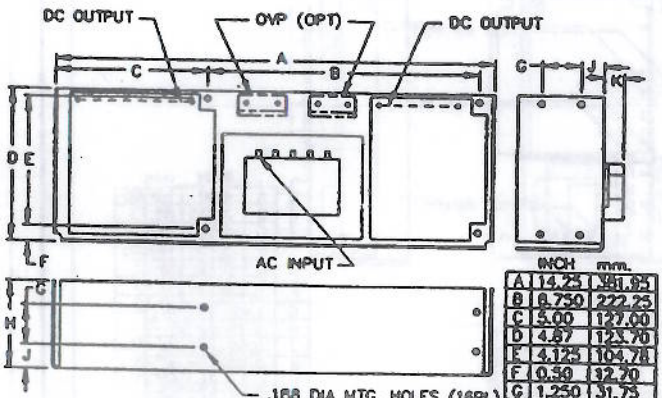
CBB CASE
WT. 8 LBS.



	INCH	mm.
A	11.00	279.40
B	7.500	190.50
C	3.00	76.20
D	4.87	123.70
E	4.125	104.78
F	0.50	12.70
G	1.250	31.75
H	0.75	19.05
J	0.525	13.34
K	2.75	69.85

FUSE AT: 2.0/1.0 AMPS FOR 100-120/220-240VAC

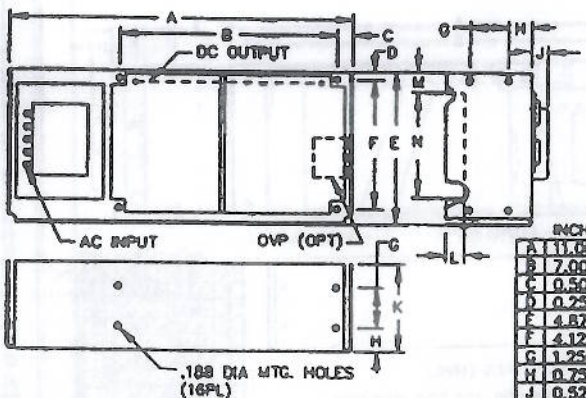
DBB CASE
WT. 11 LBS.



	INCH	mm.
A	14.25	361.95
B	8.750	222.25
C	5.00	127.00
D	4.87	123.70
E	4.125	104.78
F	0.50	12.70
G	1.250	31.75
H	2.75	69.85
J	0.75	19.05
K	0.625	15.88

FUSE AT: 3.0/1.5 AMPS FOR 100-120/220-240 VAC

131 CASE
WT. 9 LBS.



	INCH	mm.
A	11.00	279.40
B	7.000	177.80
C	0.50	12.70
D	0.25	6.35
E	4.87	123.70
F	4.125	104.78
G	1.250	31.75
H	0.75	19.05
J	0.525	13.34
K	2.75	69.85
L	0.600	15.24
M	0.640	16.26
N	3.35	85.09

FUSE AT: 3.0/1.5 AMPS FOR 100-120/220-240 VAC